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(54) **ARTICLE OF FOOTWEAR HAVING A SOLE PLATE WITH SPIKES**

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(51) **Int. Cl.**
A43B 13/22 (2006.01)
A43B 13/14 (2006.01)

(52) **U.S. Cl.**
CPC ***A43B 13/223*** (2013.01); ***A43B 13/146*** (2013.01)

(58) **Field of Classification Search**
CPC A43B 13/223; A43B 13/146; A43B 13/00; A43B 13/122; A43B 13/26; A43B 5/001; A43B 5/02
USPC ..... 33/25 R
See application file for complete search history.

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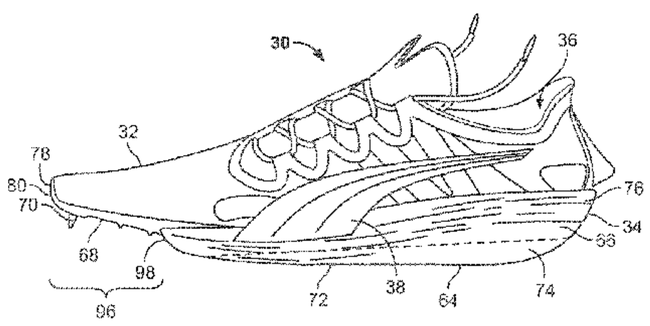
(57) **ABSTRACT**

A sole structure for an article of footwear includes an upper, an outsole, a sole plate, and a midsole structure. The sole plate is adjacent to the upper, the midsole structure is adjacent to the sole plate, and the outsole is adjacent to the midsole structure. An exposed forefoot region has the bottom wall of the sole plate uncovered by the outsole or midsole structure. A forward point and a rearward point are located along the bottom wall of the sole plate. The forward point is located at the front of the forefoot region and a rearward point is located farthest away from the forward point in the heel region. The forward point and the rearward point form a main axis line. The deepest point is the point located on the exterior of the outsole in the midfoot region that is not obstructed by midsole structure or outsole that can extend to form an inclination line to the forward point with respect to the main axis line at the highest angle. That angle is between 2 and 30 degrees.

20 Claims, 11 Drawing Sheets



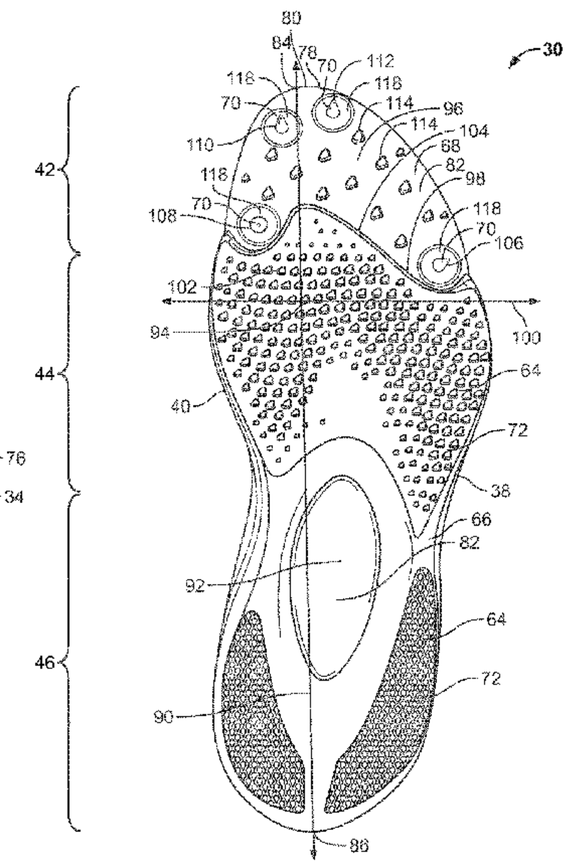


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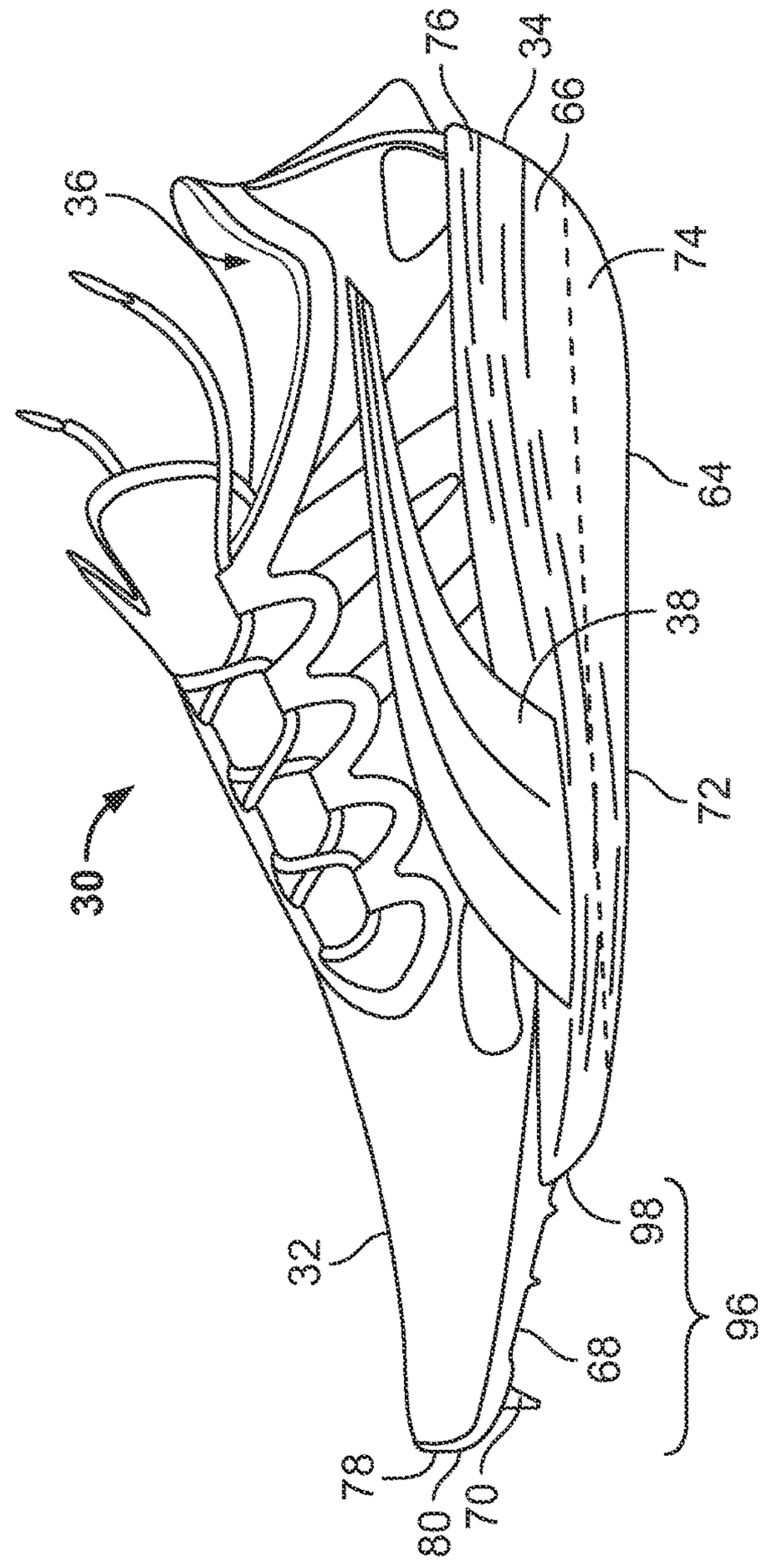
FIG. 1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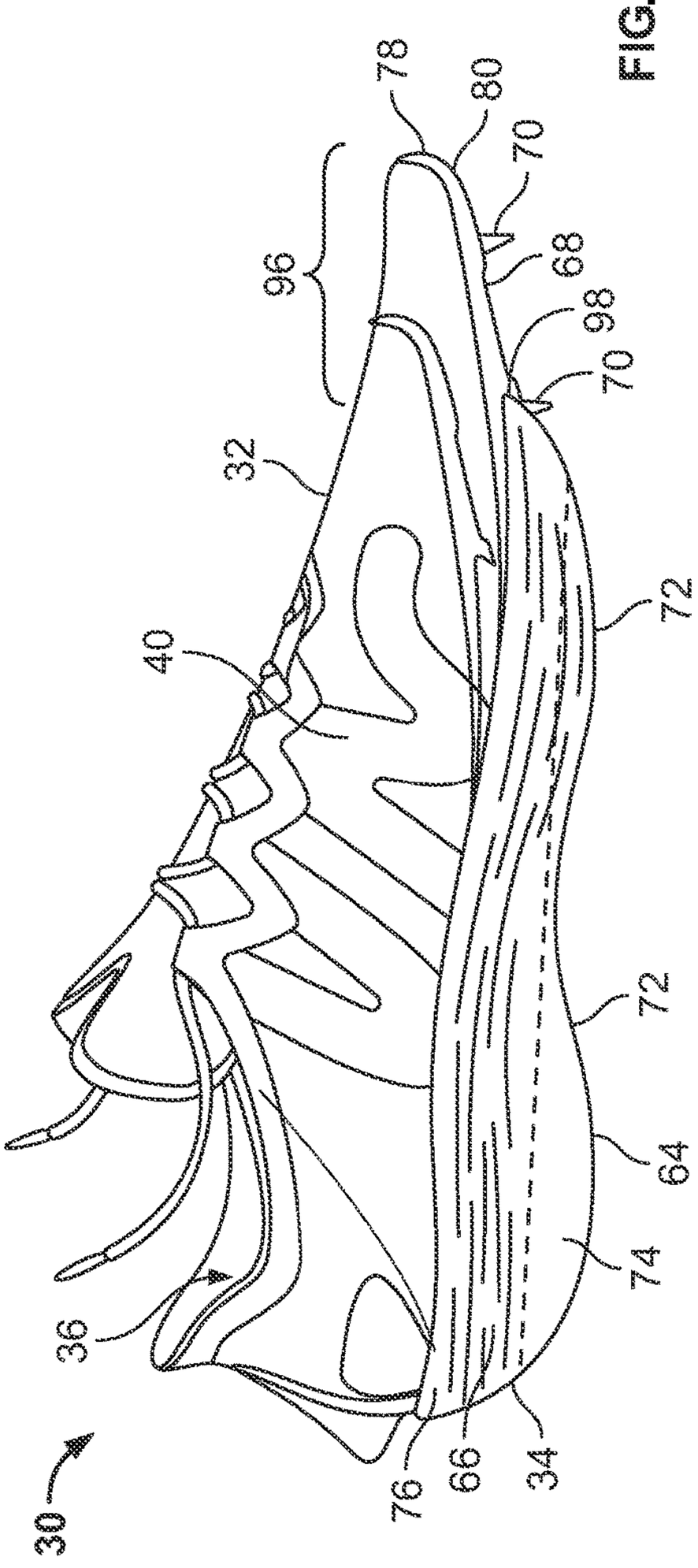
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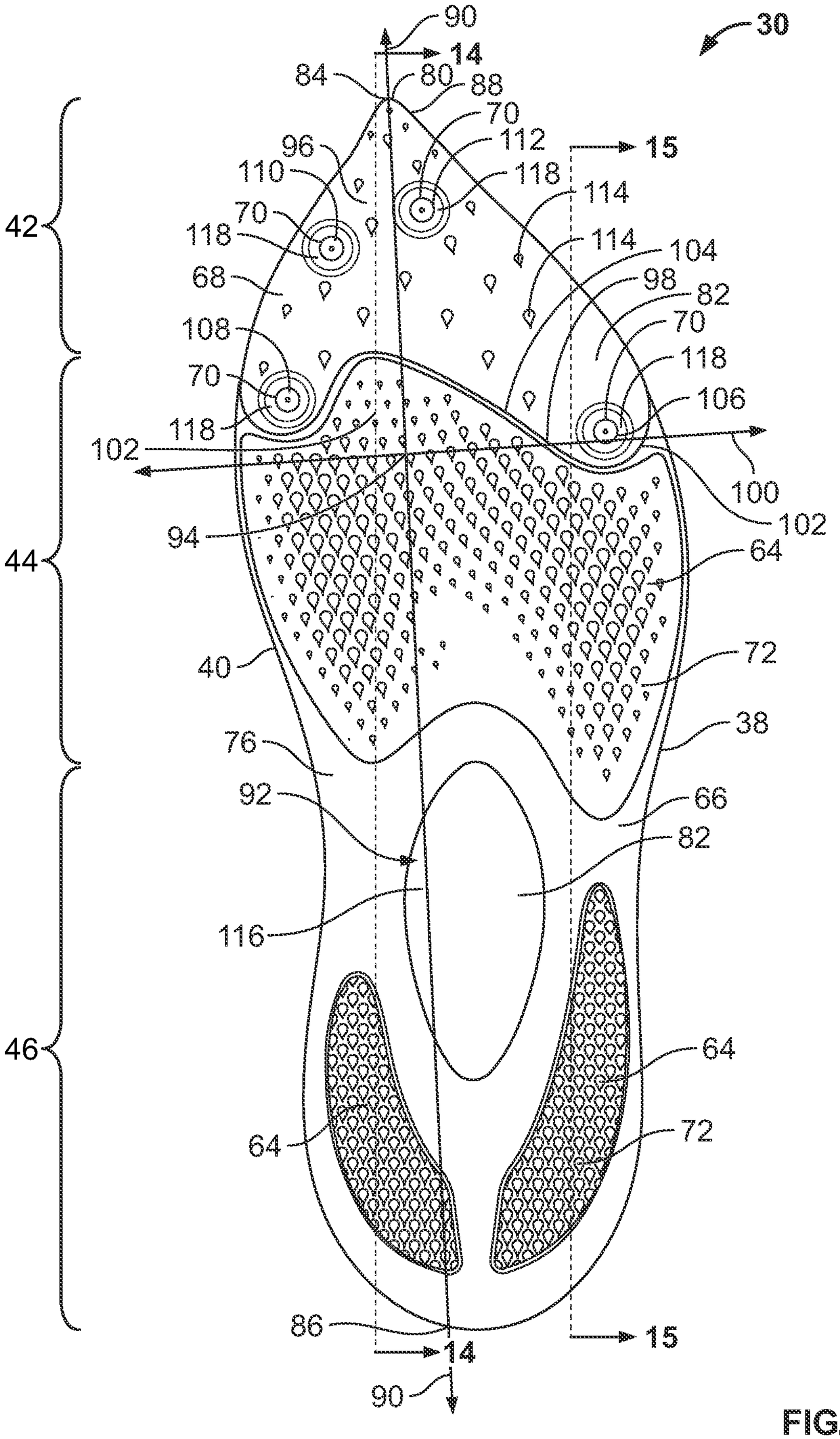
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FIG. 3

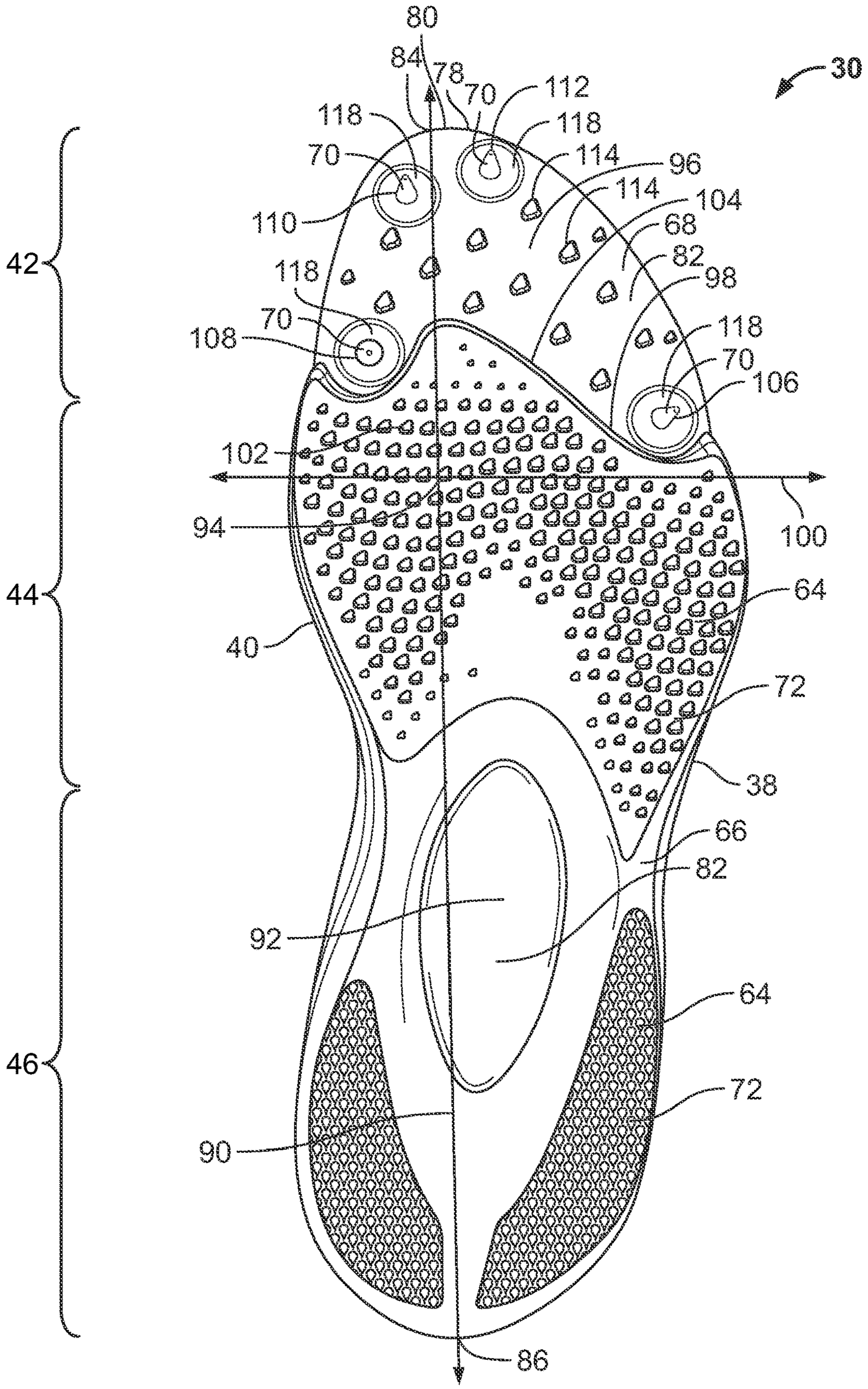
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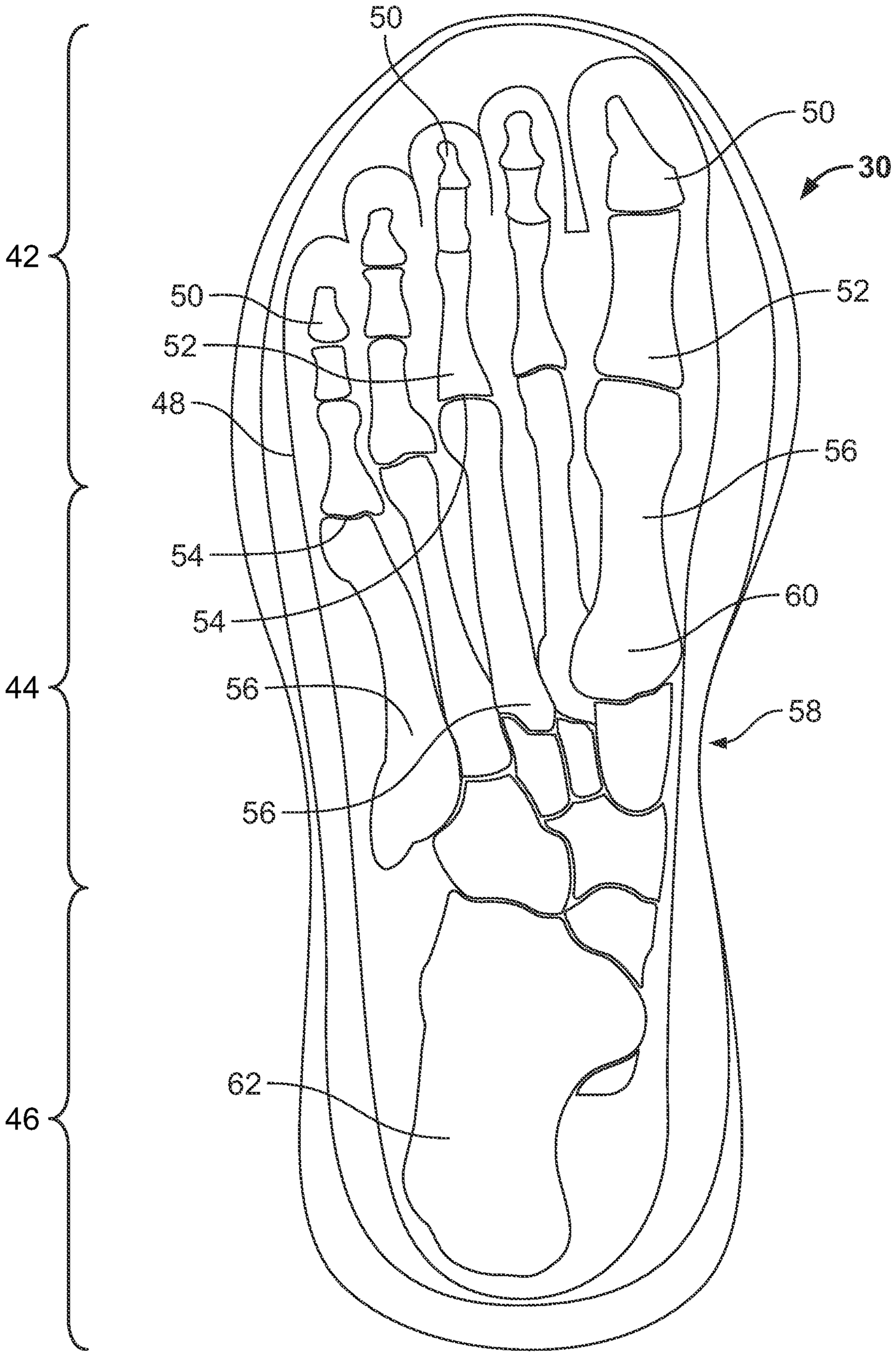
FIG. 4



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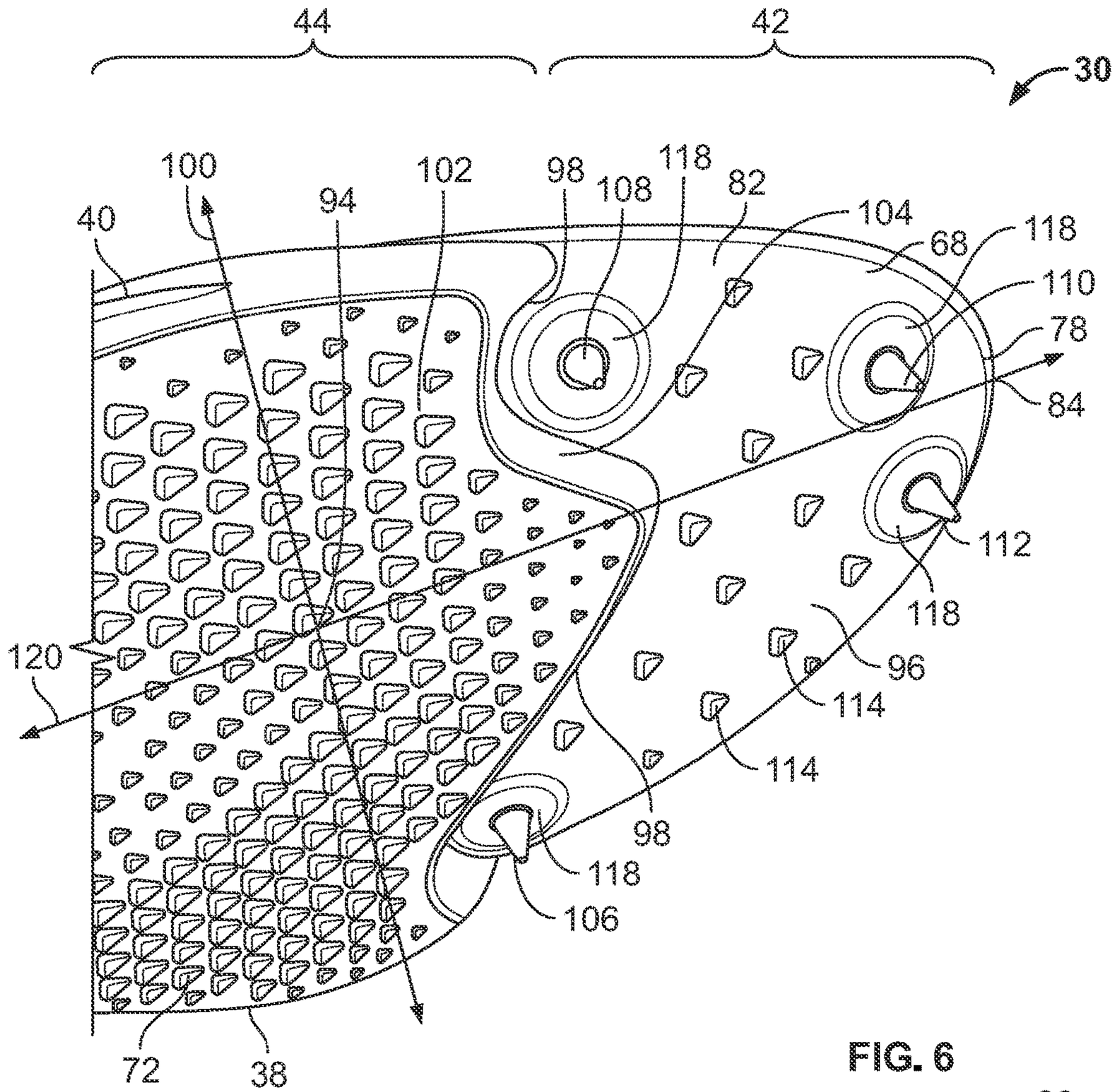
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FIG. 6

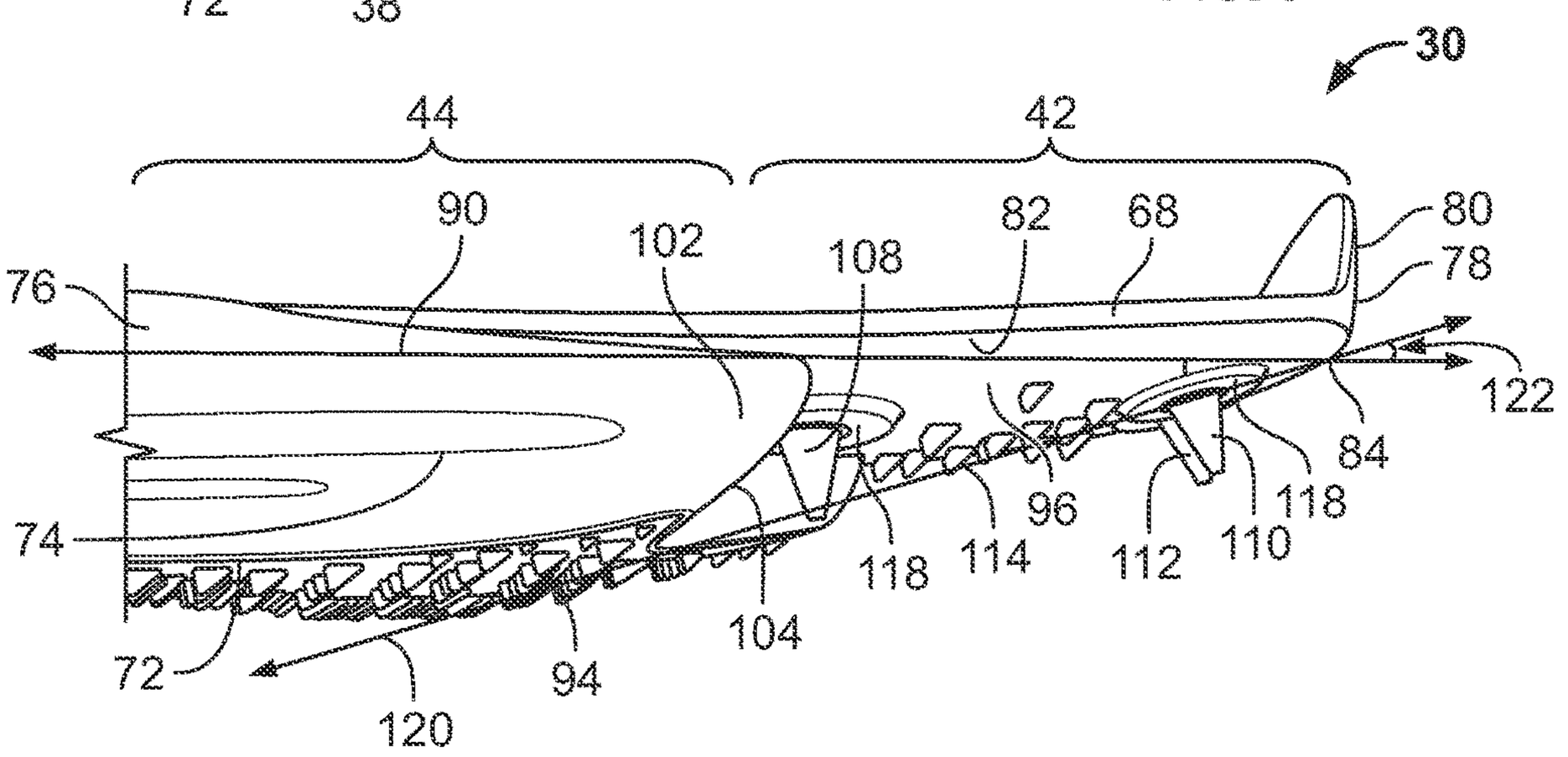
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FIG. 7

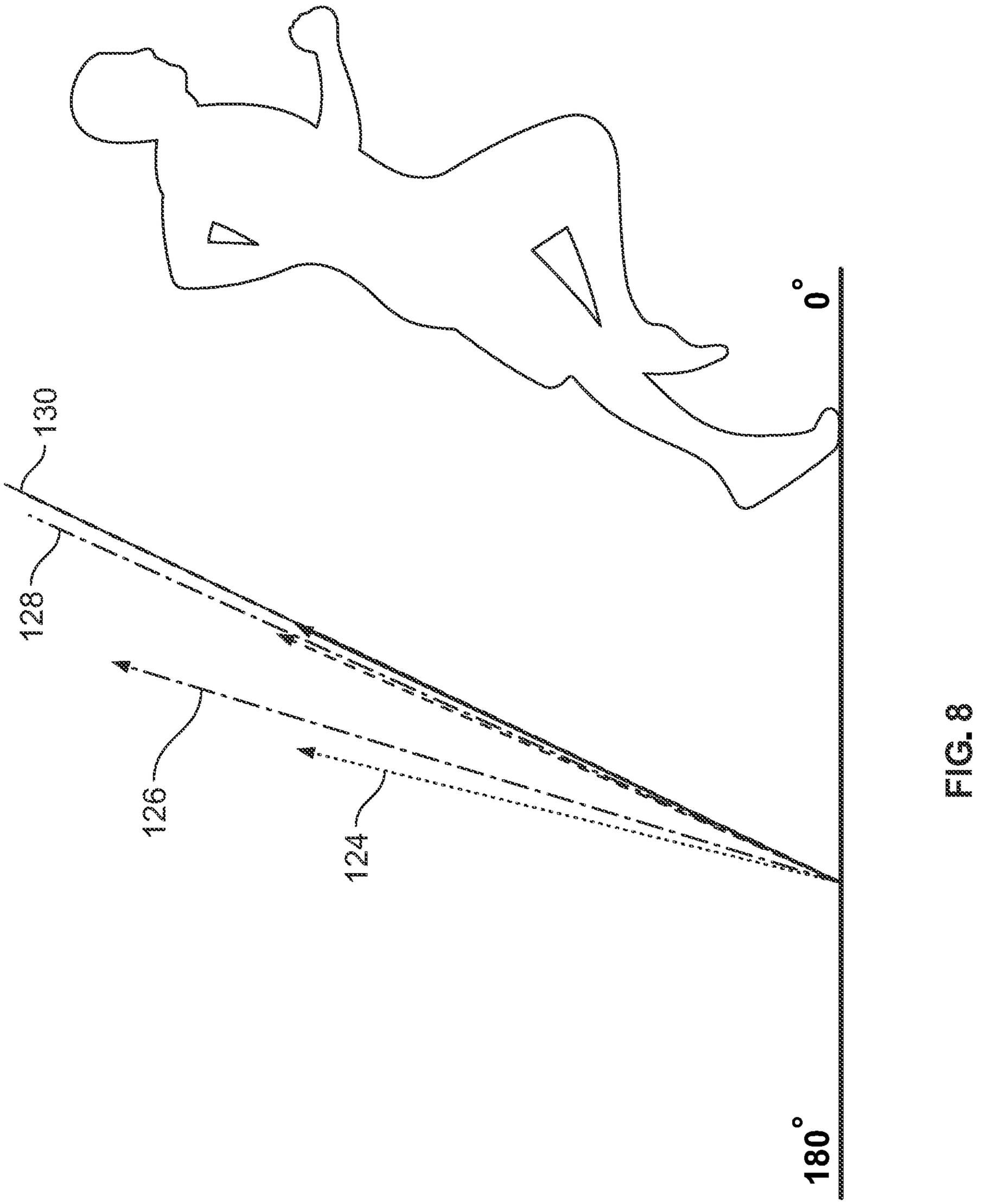


FIG. 8

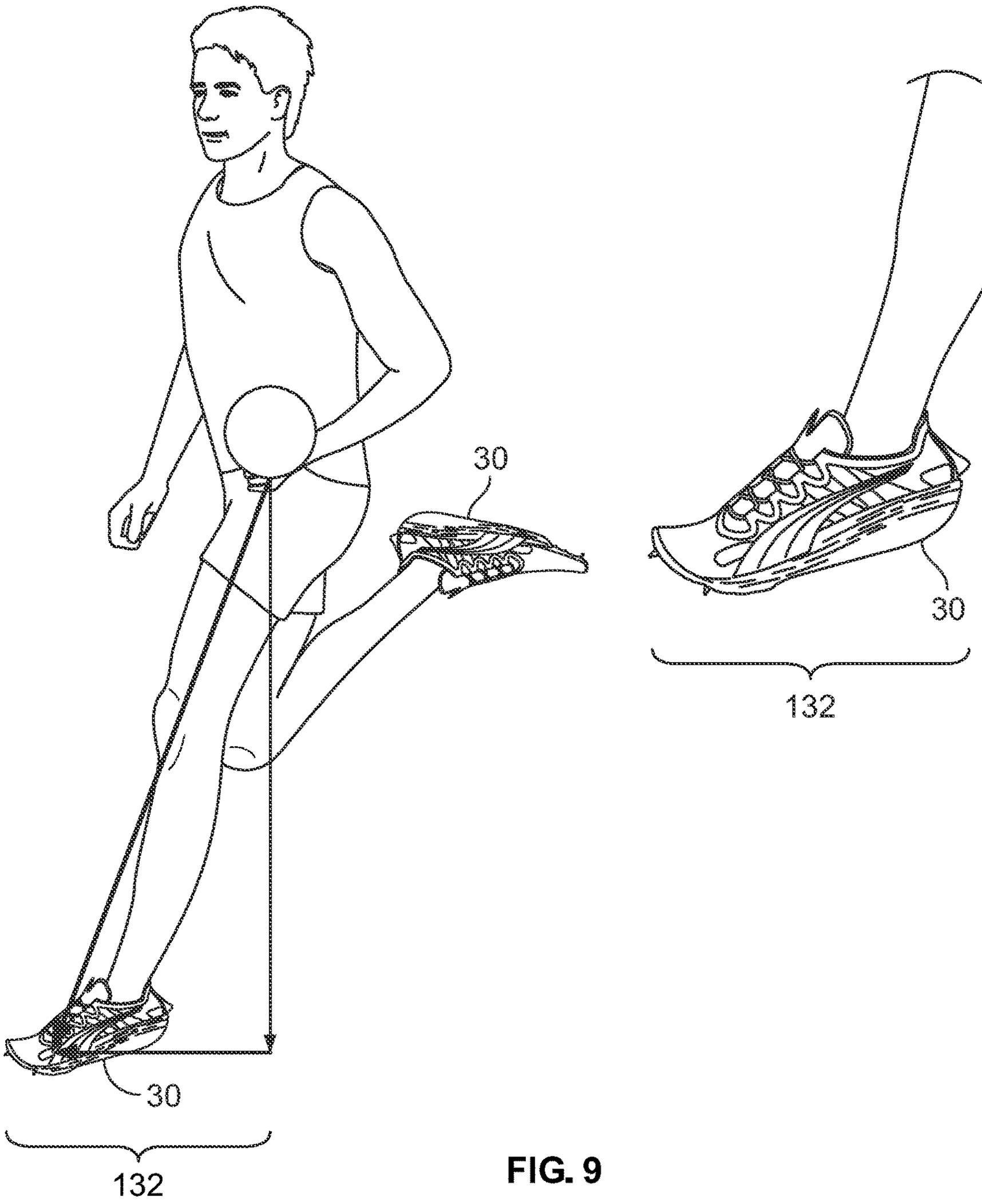


FIG. 9

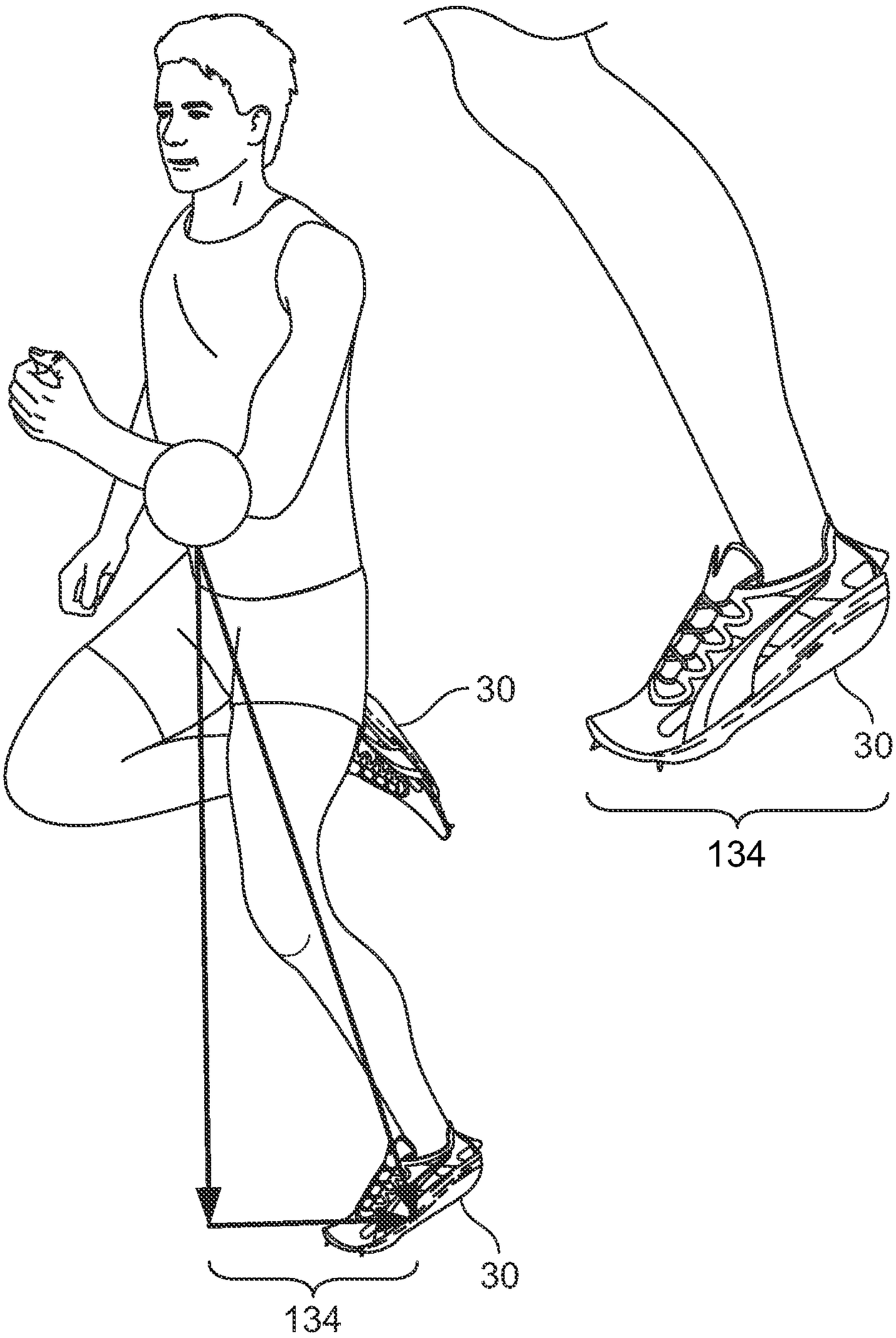


FIG. 10

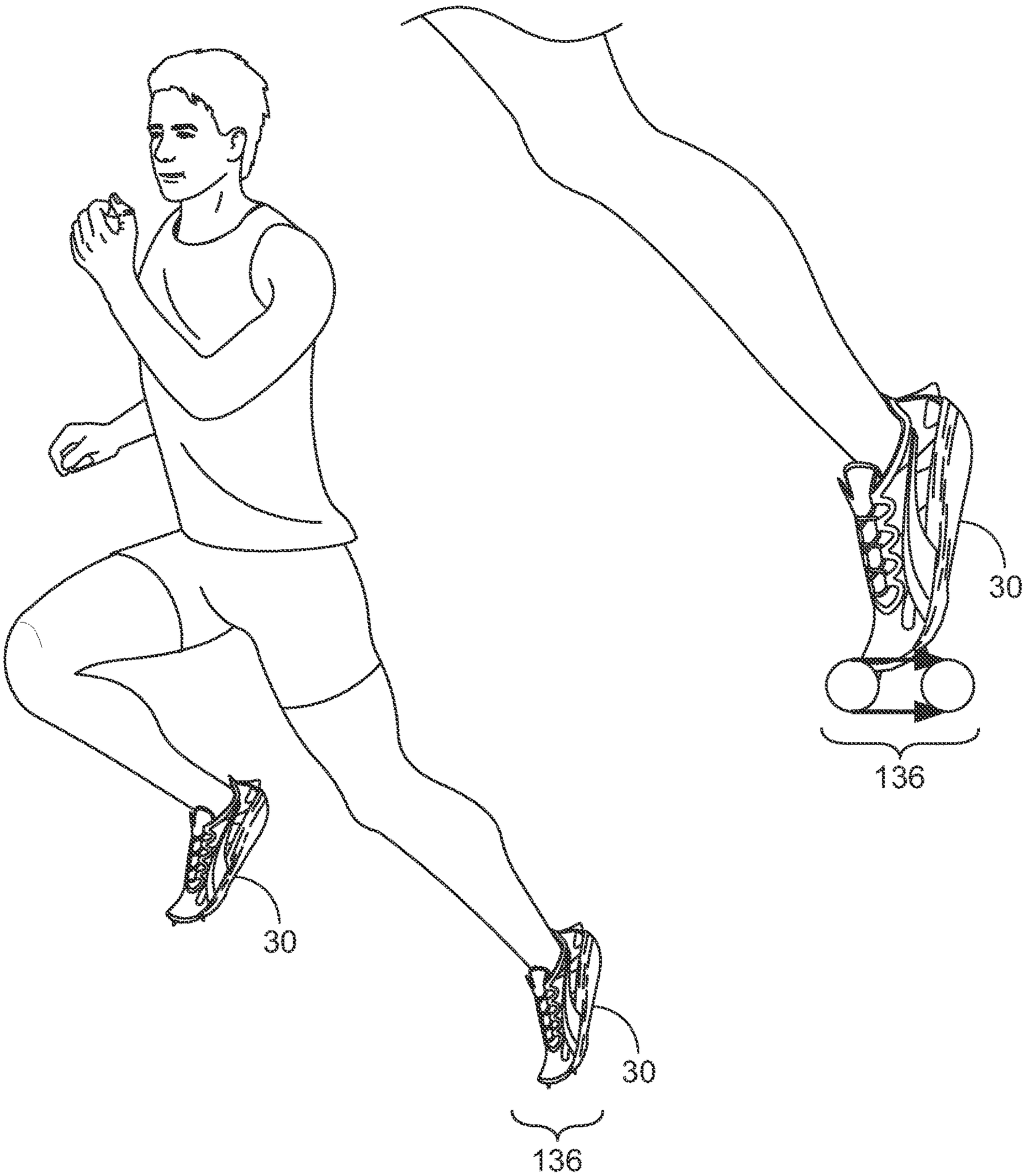
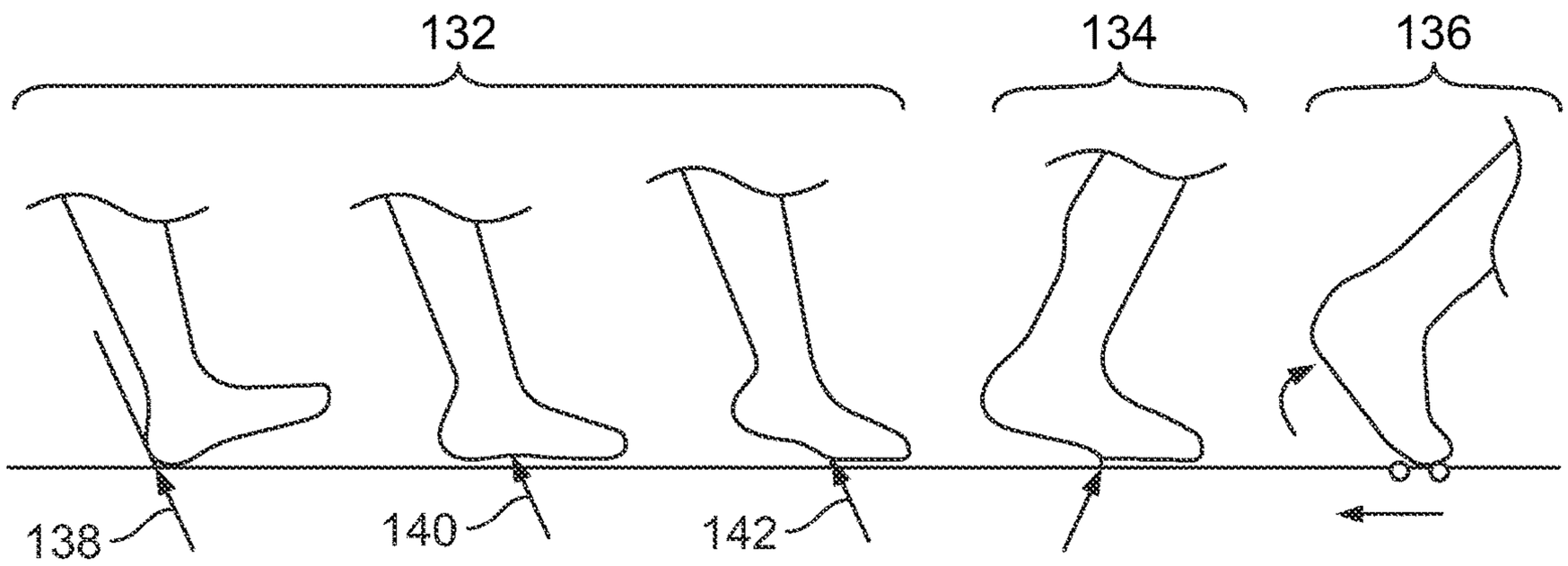


FIG. 11



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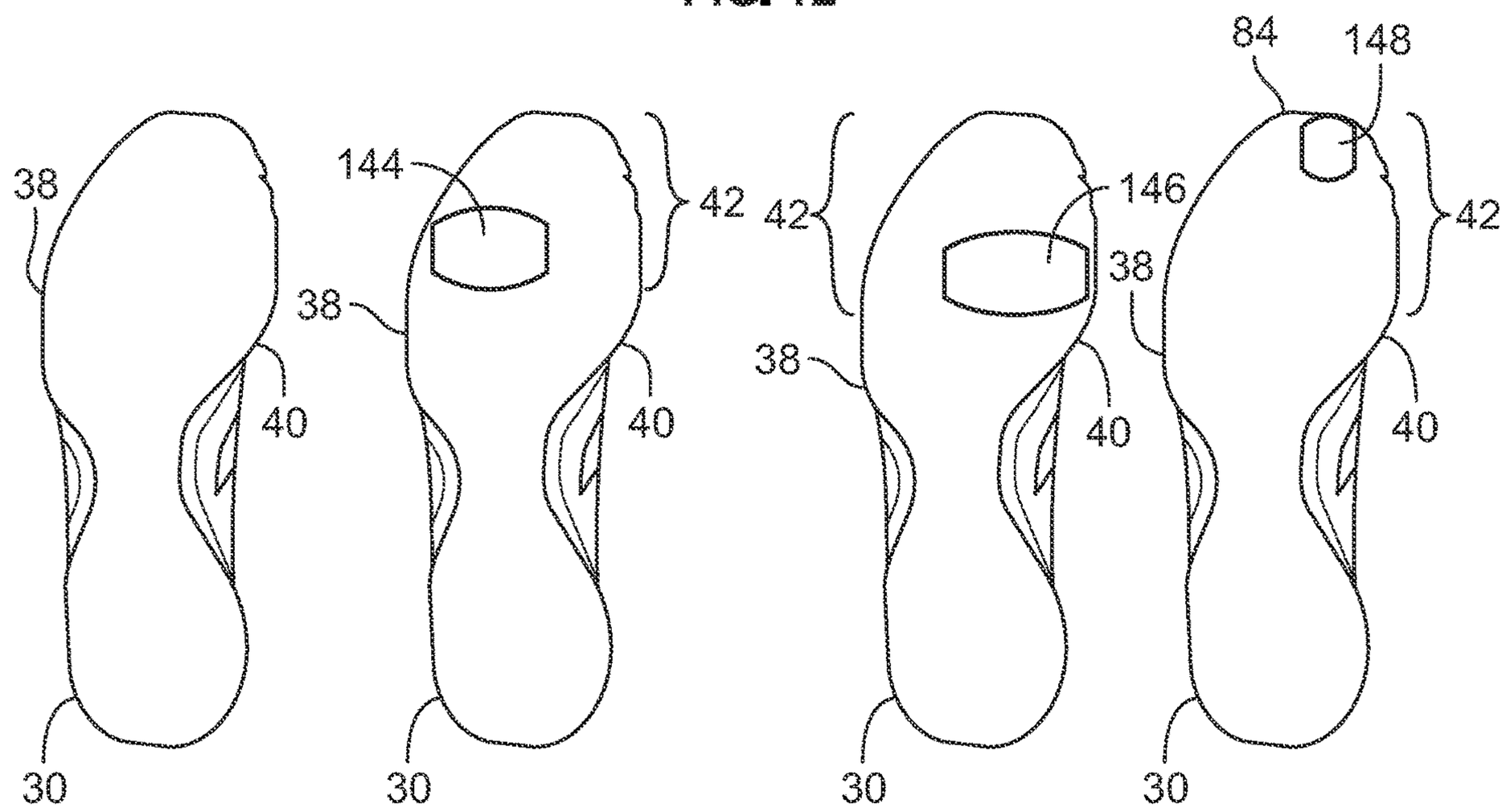

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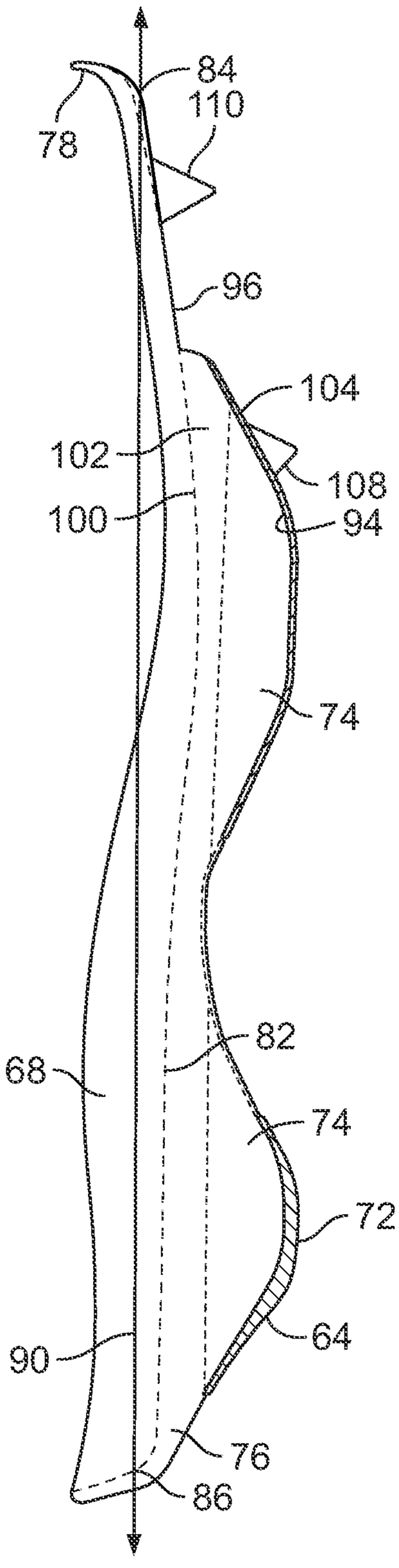
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FIG. 14

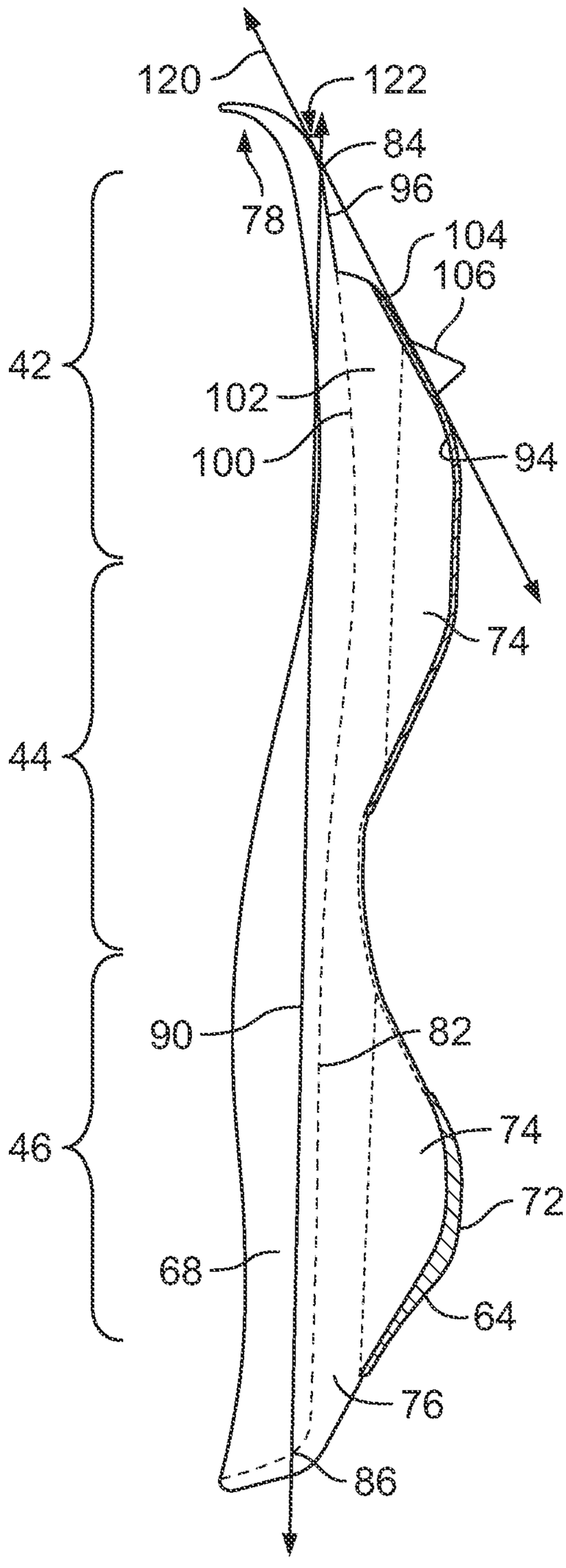
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FIG. 15

ARTICLE OF FOOTWEAR HAVING A SOLE PLATE WITH SPIKES

CROSS REFERENCE TO RELATED APPLICATIONS

Not applicable

REFERENCE REGARDING FEDERALLY SPONSORED RESEARCH OR DEVELOPMENT

Not applicable

SEQUENCE LISTING

Not applicable

BACKGROUND

1. Field of the Invention

The present disclosure relates generally to an article of footwear including a sole plate with spikes, and more particularly to a sole plate with spikes in a forefoot region that improves performance during various phases of a runner's footstep.

2. Description of the Background

Many conventional shoes or other articles of footwear generally comprise an upper and a sole attached to a lower end of the upper. Conventional shoes further include an internal space, i.e., a void or cavity, which is created by interior surfaces of the upper and the sole, which receives a foot of a user before securing the shoe to the foot. The sole is attached to a lower surface or boundary of the upper and is positioned between the upper and the ground. As a result, the sole typically provides stability and cushioning to the user when the shoe is being worn. In some instances, the sole may include multiple components, such as an outsole, a midsole, and an insole. The outsole may provide traction to a bottom surface of the sole, and the midsole may be attached to an inner surface of the outsole and may provide cushioning or added stability to the sole. For example, a sole may include a particular foam material that may increase stability at one or more desired locations along the sole, or a foam material that may reduce stress or impact energy on the foot or leg when a user is running, walking, or engaged in another activity. The sole may also include additional components, such as plates, embedded with the sole to increase the overall stiffness of the sole and reduce energy loss during use.

The upper generally extends upward from the sole and defines an interior cavity that completely or partially encases a foot. In most cases, the upper extends over the instep and toe regions of the foot, and across medial and lateral sides thereof. Many articles of footwear may also include a tongue that extends across the instep region to bridge a gap between edges of medial and lateral sides of the upper, which define an opening into the cavity. The tongue may also be disposed below a lacing system and between medial and lateral sides of the upper, to allow for adjustment of shoe tightness. The tongue may further be manipulable by a user to permit entry or exit of a foot from the internal space or cavity. In addition, the lacing system may allow a user to adjust certain dimensions of the upper or the sole, thereby allowing the upper to accommodate a wide variety of foot types having varying sizes and shapes.

The upper of many shoes may comprise a wide variety of materials, which may be utilized to form the upper and chosen for use based on one or more intended uses of the shoe. The upper may also include portions comprising varying materials specific to a particular area of the upper. For example, added stability may be desirable at a front of the upper or adjacent a heel region so as to provide a higher degree of resistance or rigidity. In contrast, other portions of a shoe may include a soft woven textile to provide an area with stretch-resistance, flexibility, air-permeability, or moisture-wicking properties.

Many runners experience energy losses or energy inefficiencies during running as a result of their footwear. When the runner's shoe initially contacts the ground, energy can be lost as the midsole in the front portion of the shoe is compressed. When the runner's shoe leaves contact with the ground, energy can be lost if the shoe loses traction. When the runner's shoe is in full contact with the ground, energy can be lost if the contact between the shoe and the ground is not strong. Also, the runner's shoe can impact the angle of inclination of the runner, which can also create lost energy.

However, in many cases, articles of footwear could benefit from having sole plates with spikes projecting from an exposed section in a forward or forefoot region of the shoe. The exposed section in the forefoot region of the shoe can create less energy loss when the runner's shoe initially contacts the ground. The exposed section in the forefoot region of the runner's shoe also facilitates a more forward angle of inclination, which can increase the energy efficiency of the runner. The spikes can help reduce energy losses by ensuring that the contact with the ground and the shoe is strong, and that traction is not lost.

SUMMARY

An article of footwear, as described herein, may have various configurations. The article of footwear may have an upper and a sole structure connected to the upper.

In some embodiments, the present disclosure can provide a sole structure for an article of footwear having an upper, a forefoot region, a midfoot region, a heel region, a medial side, and a lateral side. The sole structure has an outsole having an outsole wall located along an exterior of the outsole that is configured to be a ground-engaging surface. The sole structure has a sole plate positioned adjacent to the upper, having a bottom wall, a forward end, an exposed forefoot region, a front, a plurality of spikes, and a midsole structure positioned between the sole plate and the outsole. The forward end is located at the point in the forefoot region that is the farthest away from the heel region. The front is located at the forward end, and a forward point is located along the bottom wall and is located at the front. A rearward point is located along the bottom wall and is the point farthest away from the forward point. A main axis line is defined as a line that intersects the forward point and the rearward point. An exposed forefoot region is located in the forefoot region and is not covered by the outsole or the midsole structure.

The outsole wall has a deepest point in the midfoot region. The deepest point is defined as the point that forms the largest angle between the main axis line and an inclination line that is defined as a line that intersects the forward point and a point on the outsole wall that is not obstructed by the midsole structure or the outsole. The inclination angle is

defined as the angle formed between the main axis line and the inclination line, and is between 2 and 30 degrees. In some embodiments, the inclination angle is between 3 and 20 degrees, or between 4 and 15 degrees, or between 5 and 10 degrees, and or between 6 and 8 degrees.

In some embodiments, a sole structure for an article of footwear has an upper, a forefoot region, a midfoot region, a heel region, a medial side, and a lateral side. The sole structure has an outsole having an outsole wall located along an exterior of the outsole that is configured to be a ground-engaging surface. The sole structure has a sole plate positioned adjacent to the upper, having a bottom wall, a forward end, an exposed forefoot region, a front, a plurality of spikes, and a midsole structure positioned between the sole plate and the outsole. An exposed forefoot region is located in the forefoot region and is not covered by the outsole or the midsole structure. The plurality of spikes are located in the exposed forefoot region.

An exposed forefoot edge defines the edge between the exposed forefoot region and the midsole structure or the outsole. The forward end is located in the forefoot region and is the farthest away from the heel region. The front is located at the forward end, and a forward point is located along the bottom wall and is located at the front. At least one of the plurality of spikes is located adjacent to the medial side and the exposed forefoot edge, at least one of the plurality of spikes is located adjacent to the lateral side and the exposed forefoot edge, and at least one of the plurality of spikes is located adjacent to the forward point. In some embodiments, the plurality of spikes has a first spike, a second spike, a third spike, and a fourth spike.

In some embodiments, the third spike and the fourth spike are located adjacent to the forward point. In some embodiments, the exposed forefoot region has a plurality of barbs, and each of the plurality of barbs is shorter than each of the plurality of spikes. In some embodiments, the front projects away from the bottom wall and toward the upper. In some embodiments, each of the plurality of spikes has an embossment that projects from the bottom wall and concentrically surrounds each of the plurality of spikes. In some embodiments, the midfoot region or the heel region has a cutout portion where the bottom wall is not covered by the midsole structure or the outsole.

In some embodiments, a sole structure for an article of footwear has an upper, a forefoot region, a midfoot region, a heel region, a medial side, and a lateral side. The sole structure has an outsole having an outsole wall located along an exterior of the outsole that is configured to be a ground-engaging surface. The sole structure has a sole plate positioned adjacent to the upper, having a bottom wall, a forward end, an exposed forefoot region, a front, a plurality of spikes, and a midsole structure positioned between the sole plate and the outsole. An exposed forefoot region is located in the forefoot region and is not covered by the outsole or the midsole structure. An exposed forefoot edge defines the edge between the exposed forefoot region and the midsole structure or the outsole. The forward end is located in the forefoot region and is the farthest away from the heel region. The front is located at the forward end, and a forward point is located along the bottom wall and is located at the front. A rearward point is located along the bottom wall and is the farthest away from the forward point.

A main axis line is defined as a line that intersects the forward point and the rearward point. The outsole wall has a deepest point in the midfoot region. The deepest point is defined as the point that forms the largest angle between the main axis line and an inclination line that is defined as a line that intersects the forward point and a point on the outsole wall that is not obstructed by the midsole structure or the outsole. A transition line is located along the bottom wall, projecting perpendicularly with respect to the main axis line, extending from the lateral side to the medial side, and is the closest to the deepest point. An undulating portion is defined as a region bounded by the transition line and the exposed forefoot edge, extending from the medial side to the lateral side. The sole structure within the undulating portion slopes toward the bottom wall.

In some embodiments, the front projects away from the bottom wall and toward the upper. In some embodiments, the exposed forefoot edge is a wavy continuous line. In some embodiments, the plurality of spikes are integrally formed with the sole plate. In some embodiments, the first spike is located adjacent to the exposed forefoot edge and the lateral side, and the second spike is located adjacent to the exposed forefoot edge and the medial side. In some embodiments, the third spike, and the fourth spike are located adjacent to the forward point.

Other aspects of the article of footwear, including features and advantages thereof, will become apparent to one of ordinary skill in the art upon examination of the figures and detailed description herein. Therefore, all such aspects of the article of footwear are intended to be included in the detailed description and this summary.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** is a lateral side view of an article of footwear configured as a left shoe that includes an upper and a sole structure according to an embodiment of the disclosure;

FIG. **2** is a medial side view of the shoe of FIG. **1**;

FIG. **3** is a bottom view of the shoe of FIG. **1**;

FIG. **4** is a bottom view of a second embodiment of the shoe of FIG. **1**;

FIG. **5** is a top plan view of the article of footwear of FIG. **1**, with an upper removed and a user's skeletal foot structure overlaid thereon;

FIG. **6** is a bottom perspective view of an underside of the shoe of FIG. **1**;

FIG. **7** is a side view of the underside of the shoe of FIG. **1**;

FIG. **8** is graph illustrating a group of runner's average force vector in the vertical and horizontal directions depending upon the specific group of runner's angle of inclination;

FIG. **9** is an image in a sequence of a runner during a first phase of a footstep;

FIG. **10** is an image in a sequence of a runner during a second phase of a footstep;

FIG. **11** is an image in a sequence of a runner during a third phase of a footstep;

FIG. **12** illustrates various phases of a footstep being taken by a runner or walker;

FIG. **13** illustrates various zones on the bottom of the shoe of FIG. **1** for the first, second, and third phases of a footstep;

FIG. **14** is a cross section taken through line **14-14** of FIG. **3**; and

FIG. **15** is a cross section taken through line **15-15** of FIG. **3**.

DETAILED DESCRIPTION OF THE DRAWINGS

The following discussion and accompanying figures disclose various embodiments of a shoe or article of footwear, e.g., a running shoe, tennis shoe, basketball shoe, etc., and concepts associated with embodiments of the shoe and sole

structure thereof may be applied to a wide range of footwear and footwear styles, including cross-training shoes, football shoes, lifestyle shoes, golf shoes, hiking shoes, hiking boots, ski and snowboard boots, soccer shoes and cleats, walking shoes, and track cleats, for example. Concepts of the shoe or the sole structure described herein may also be applied to articles of footwear that are considered non-athletic, including dress shoes, sandals, loafers, slippers, and heels.

The term "about," as used herein, refers to variation in the numerical quantity that may occur, for example, through typical measuring and manufacturing procedures used for articles of footwear or other articles of manufacture that may include embodiments of the disclosure herein; through inadvertent error in these procedures; through differences in the manufacture, source, or purity of the ingredients used to make the compositions or mixtures or carry out the methods; and the like. Throughout the disclosure, the terms "about" and "approximately" refer to a range of values±5% of the numeric value that the term precedes.

The terms "weight percent," "wt-%," "percent by weight," "% by weight," and variations thereof, as used herein, refer to the concentration of a substance or component as the weight of that substance or component divided by the total weight, for example, of the composition or of a particular component of the composition, and multiplied by 100. It is understood that, as used herein, "percent," "%," and the like may be synonymous with "weight percent" and "wt-%."

The present disclosure is directed to an article of footwear and/or specific components of the article of footwear, such as an upper and/or a sole or sole structure. The upper may comprise a knitted component, a woven textile, and/or a non-woven textile. The knitted component may be made by knitting of yarn, the woven textile by weaving of yarn, and the non-woven textile by manufacture of a unitary non-woven web. Knitted textiles include textiles formed by way of warp knitting, weft knitting, flat knitting, circular knitting, and/or other suitable knitting operations. The knit textile may have a plain knit structure, a mesh knit structure, and/or a rib knit structure, for example. Woven textiles include, but are not limited to, textiles formed by way of any of the numerous weave forms, such as plain weave, twill weave, satin weave, dobbin weave, jacquard weave, double weaves, and/or double cloth weaves, for example. Non-woven textiles include textiles made by air-laid and/or spun-laid methods, for example. The upper may comprise a variety of materials, such as a first yarn, a second yarn, and/or a third yarn, which may have varying properties or varying visual characteristics.

The word "runner" used herein should not be interpreted in a narrow sense, but encompasses activities including but not limited to shuffling, walking, hopping, jumping, leaping, skipping, jogging, running, and sprinting. The word "runner" is defined herein as a person taking a footstep, regardless of their horizontal speed. A footstep begins when the shoe contacts the ground, and ends when the shoe leaves contact with the ground. A runner then takes a stride and moves the shoe forward to begin the next footstep.

FIGS. **1** and **2** depict an embodiment of an article of footwear or shoe **30**, configured as a left shoe, which includes an upper **32** and a sole structure **34**. The upper **32** is attached to the sole structure **34** and together define an interior cavity **36** into which a foot may be inserted. The article of footwear **30** also includes a lateral side **38** as illustrated in FIG. **1** and a medial side **40** as illustrated in FIG. **2**. When a user is wearing the article of footwear **30**, the lateral side **38** corresponds to an outside-facing portion of the article of footwear **30**. In other words, the lateral side **38** is the side of the shoe **30** that is the most distal from the other shoe **30**. The medial side **40** corresponds to an inside-facing portion of the article of footwear **30**. In other words, the medial side **40** is the side of the shoe that is faces the other shoe. As such, left and right articles of footwear have opposing lateral and medial sides, such that the medial sides **40** are closest to one another when a user is wearing the articles of footwear **30**, while the lateral sides **38** are defined as the sides that are farthest from one another while being worn. The medial side **40** and the lateral side **38** adjoin one another at opposing, distal ends of the article of footwear **30**.

While only a single article of footwear **30** is depicted, i.e., a shoe that is worn on a left foot of a user, it should be appreciated that the concepts disclosed herein are applicable to a pair of shoes (not shown), which includes a left shoe and a right shoe that may be sized and shaped to receive a left foot and a right foot of a user, respectively. For ease of disclosure, a single shoe **30** will be referenced to describe aspects of the disclosure. The disclosure below with reference to the article of footwear **30** is applicable to both a left shoe and a right shoe. However, in some embodiments there may be differences between a left shoe and a right shoe other than the left/right configuration. Further, in some embodiments, a left shoe may include one or more additional elements that a right shoe does not include, or vice versa.

FIG. **5** illustrates a schematic top view of the article of footwear **30**, which defines a forefoot region **42**, a midfoot region **44**, and a heel region **46**. The forefoot region **42** generally corresponds with portions of the article of footwear **30** that encase portions of a foot **48** that include a set of toes or phalanges **50**, a ball **52** of the foot **48**, and a set of joints **54** connecting a set of metatarsals **56** with the set of toes **50**. The midfoot region **44** is adjacent to and adjoining the forefoot region **42**, and generally corresponds with portions of the article of footwear **30** that encase an arch **58** of the foot **48**, along with a bridge **60** of the foot **48**. The heel region **46** is adjacent to and adjoining the midfoot region **44** and generally corresponds with portions of the article of footwear **30** that encase rear portions of the foot **48**, including a heel or calcaneus bone **62**, an ankle (not shown), and/or an Achilles tendon (not shown).

Unless otherwise specified, the forefoot region **42**, the midfoot region **44**, the heel region **46** (see FIG. **5**), the medial side **40**, and the lateral side **38** (see FIGS. **1** and **2**) are intended to define boundaries or areas of the article of footwear **30**. To that end, the forefoot region **42**, the midfoot region **44**, the heel region **46**, the medial side **40**, and the lateral side **38** generally characterize sections of the article of footwear **30**. Further, both the upper **32** and the sole structure **34** may be characterized as having portions within the forefoot region **42**, the midfoot region **44**, the heel region **46**, and on the medial side **40** and the lateral side **38**. Therefore, the upper **32** and the sole structure **34** (see FIGS. **1** and **2**), and/or individual portions of the upper **32** and the sole structure **34**, may include portions thereof that are disposed within the forefoot region **42**, the midfoot region **44**, the heel region **46**, and on the medial side **40** and the lateral side **38**.

Referring again to FIGS. **1** and **2**, the sole structure **34** includes an outsole **64**, a midsole structure **66**, and a sole plate **68** with a plurality of spikes **70**. In some embodiments, an insole (not shown) is disposed between the midsole structure **66** and the upper **32**. The outsole **64** has an outer or bottom wall **72** that is located on an exterior side of the outsole **64** and is configured to contact the ground or running surface. In some embodiments, the midsole structure **66** can

include a first midsole member **74** that is adjacent to the outsole **64** and a second midsole member **76** that is adjacent to the first midsole member **74** and the sole plate **68**. The sole plate **68** is adjacent to the upper **32**, located generally between the midsole structure **66** and the upper **32**. In some embodiments, the insole is positioned between the sole plate **68** and the upper **32**. In some embodiments, the upper **32** can be secured to the insole in whole or in part.

Many conventional footwear uppers are formed from multiple elements (e.g., textiles, polymer foam, polymer sheets, leather, and synthetic leather) that are joined through bonding or stitching at a seam. In some embodiments, the upper **32** of the article of footwear **30** is formed from a knitted structure or knitted components. In various embodiments, a knitted component may incorporate various types of yarn that may provide different properties to an upper. For example, one area of the upper **32** may be formed from a first type of yarn that imparts a first set of properties, and another area of the upper **32** may be formed from a second type of yarn that imparts a second set of properties. Using this configuration, properties of the upper **32** may vary throughout the upper **32** by selecting specific yarns for different areas of the upper **32**. In another example, an upper mesh layer may be warp knit, while a mesh backing layer may comprise a circular knit.

Still referring to FIGS. **1** and **2**, the upper **32** can be secured to the sole plate **68** in whole or in part. The sole plate **68** of FIG. **1** further includes a rounded front **78** (see FIGS. **1** and **4**) that projects toward the upper **32** at a forward end **80** of the sole plate **68** in the forefoot region **42**. The forward end **80** is the point (or points) the farthest away from the heel region. Said another way, the forward end **80** is the most distal portion of the sole plate **68** to the heel region **46**, which could comprise a point, an edge, or one or more regions. The first midsole member **74** may be constructed from a thermoplastic material, such as polyurethane (PU) plastic, for example, and the second midsole member **76** may be constructed from ethylene-vinyl acetate (EVA), copolymers thereof, or a similar type of material. In other embodiments, each of the first midsole member **74** and the second midsole member **76** may be constructed from the same material. In other embodiments, the first midsole member **74** and/or the second midsole member **76** may be an EVA-Solid-Sponge ("ES S") material, an EVA foam (e.g., PUMA® ProFoam Lite™, IGNITE Foam), polyurethane, polyether, an olefin block copolymer, a thermoplastic material (e.g., a thermoplastic polyurethane, a thermoplastic elastomer, a thermoplastic polyolefin, etc.), or a supercritical foam. The first midsole member **74** and/or the second midsole member **76** may be a single polymeric material or may be a blend of materials, such as an EVA copolymer, a thermoplastic polyurethane, a polyether block amide (PEBA) copolymer, and/or an olefin block copolymer.

Still referring to FIGS. **1** and **2**, in some embodiments, the sole plate **68** comprises a polyurethane (PU) plastic, such as a thermoplastic polyurethane (TPU) material, for example. Other thermoplastic elastomers and fiber reinforced thermoplastics consisting of block copolymers are also possible. In other embodiments, the sole plate **68** can include carbon fiber, for example. In some embodiments, these and other rigid, semi-rigid, or spring-like materials and combinations thereof may comprise the sole plate **68**. The sole plate **68** can have varied stiffness and shape along the length of the sole plate **68**. For example, the stiffness in the forefoot region **42** (the forefoot region **42**, the midfoot region **44**, and the heel region **46** are shown in FIGS. **3-5** for clarity) of the sole plate **68** may be more or less flexible than the midfoot region **44** of the sole plate **68**, which may be more or less flexible than the heel region **46** of the sole plate **68**. Alternatively, the sole plate **68** can include a uniform stiffness. Additionally, the sole plate **68** may include additional or alternative geometries, such as, for example, notches, curves, protrusions, voids, angled edges, cutouts, etc. In some embodiments, the sole plate **68** can be configured as a shock plate to impart impact protection and facilitate leg muscle tension, thereby relieving stress on a heel, ankle, shin, knees, hips, and/or back of a user. Due to the spring-like features of the materials chosen to make the sole plate **68**, the sole plate **68** is suitable for providing a return or spring back force during each footstep as the sole plate **68** is first compressed, and then later released from the impact of a footstep.

The sole plate **68** provides for a rigid sole that can promote a faster takeoff when running. In particular, the shape and rigidity of the sole plate **68** acts as a propulsion lever between the midfoot region **44** and the heel region **46** of the wearer that allows the wearer to accelerate faster and create a toe off movement where the forefoot region **42** of the wearer propels the wearer forward. Further, embodiments of the sole structures described herein can provide a training aid or tool that can be used to strengthen entire leg and foot muscles of a wearer and adjust their running posture to a forward-tilt position that promotes constant muscle tension.

Still referring to FIGS. **1** and **2**, the sole structure **34** is connected or secured to the upper **32** and extends between a foot of a user and the ground when the article of footwear **30** is worn by the user. The sole structure **34** may include one or more components, which may include the outsole **64**, the midsole structure **66**, a heel (not shown), a vamp (not shown), and/or the insole (not shown). For example, in some embodiments, the sole structure **34** may include the outsole **64** that provides structural integrity to the sole structure **34**, along with traction for a user, the midsole structure **66** that provides a cushioning system, and the insole that provides support for the arch **58** of a user (see FIG. **5**). As will be further discussed herein, the sole structure **34** of the present embodiment includes one or more components that provide the sole structure **34** with preferable spring and damping properties. In addition, the sole structure **34** of the present embodiment comprises the sole plate **68** with the plurality of spikes **70** for better traction and structure to improve the angle of inclination of the runner while taking a footstep.

FIGS. **3** and **4** illustrate first and second embodiments of the sole plate **68**, and therefore the sole structure **34**, of the article of footwear **30**. FIG. **4** illustrates a rounded front **78** at a forward end **80** of the sole plate **68**. The rounded front **78** extends in the direction of the upper **32** (see FIG. **7**), and away from a bottom wall **82** of the sole plate **68**. A forward point **84** is defined as the point along the bottom wall **82** that is located closest to the rounded front **78**. In other words, the forward point **84** is generally the most forward point of the bottom wall **82** in the forefoot region **42**. A rearward point **86** is defined as the point on the bottom wall **82** of the sole plate **68** that is located the farthest away or most distal from the forward point **84**. In other words, the rearward point is generally the most rearward point of the bottom wall **82** in the heel region **46**.

FIG. **3** illustrates a pointed front **88**. The pointed front **88** of FIG. **3** and the rounded front **78** of FIG. **4** are each formed as an integral portion of the sole plate **68**. A main axis **90** is defined as a line that intersects the forward point **84** and the rearward point **86** (see FIG. **3**). The pointed front **88** is more suitable for races that have fewer curves or turns, and the rounded front **78** is more suitable for races that have more

curves or turns. Referring to FIGS. **3** and **4**, the midsole structure **66** and the outsole **64** generally cover the sole plate **68** along the bottom wall **82** in the midfoot region **44** and the heel region **46**. In some embodiments, the midfoot region **44**, the heel region **46**, or both regions may have a cutout portion **92** where the bottom wall **82** of the sole plate **68** is not covered by midsole structure **66** or the outsole **64**. The midsole structure **66** defines the cutout portion **92**. The bottom wall **82** of the sole plate **68** is exposed at the cutout portion **92**. The outsole **64** may be formed from one or more materials to impart durability, wear-resistance, abrasion resistance, or traction to the sole structure **34**. In some embodiments, the outsole **64** may be formed from rubber, for example.

Referring to FIGS. **3**, **4**, and **7**, the bottom wall **72** has a deepest point **94** in the midfoot region **44**. The deepest point **94** is defined as the point on the bottom wall **72** in the midfoot region **44** that forms the largest angle with respect to the forward point **84** about the main axis **90**, and which is located farthest from the forward point **84** and is not obstructed by the midsole structure **66** or the outsole **64** along a line formed between the deepest point **94** and the forward point **84** (see FIG. **15**). The deepest point **94** may be the lowest spot on the bottom wall **72** in the midfoot region **44**; however the present embodiment depicts the deepest point **94** adjacent the lowest spot on the bottom wall **72**. The bottom wall **82** of the sole plate **68** is not limited to being a flat surface, and may comprise contours or undulations or other configurations.

Referring to FIGS. **3** and **4**, from the rounded front **78** or the pointed front **88** to at least a portion of the forefoot region **42**, the bottom wall **82** of the sole plate **68** is not covered by midsole structure **66** or by the outsole **64**. This exposed region of the bottom wall **82** of the sole plate **68** in the forefoot region **42** is defined as an exposed forefoot region **96**. The boundary where the exposed forefoot region **96** ends and the bottom wall **82** of the sole plate **68** begins to be covered by either the outsole **64**, the midsole structure **66**, or both, is defined as an exposed forefoot edge **98**. The exposed forefoot edge **98** may be a straight line, a wavy line, a jagged line, a contoured line, or any style of continuous line that reaches from the medial side **40** of the shoe **30** to the lateral side **38** of the shoe **30**. A transition line **100** extends from the medial side **40** to the lateral side **38** of the shoe **30** along the bottom wall **82** of the sole plate **68**, projecting perpendicular to the main axis **90**, and positioned the closest to the deepest point **94**. In other words, the transition line **100** extends from the lateral side **38** to the medial side **40** of the shoe **30** through the deepest point **94** when viewed from above.

The midfoot region **44** and the forefoot region **42** are further defined by a transition zone **102**. The transition zone **102** is the region bounded by the exposed forefoot edge **98** at a first end, and by the transition line **100** at a second end. In FIG. **3**, the transition zone **102** near the lateral edge **38** has the exposed forefoot edge **98** farther away from the forward point **84** than the transition line **100**. However, the transition zone **102** near the medial edge **40** has the exposed forefoot edge **98** closer to the forward point **84** than the transition line **100**. In other words, the transition zone **102** can have various segments, but each segment slopes toward the bottom wall **82** of the sole plate **68**. The transition zone **102** spans from the medial side **40** of the shoe **30** to the lateral side **38** of the shoe **30**. Since the deepest point **94** is a point along the bottom wall **72** of the outsole **64** in the midfoot region **44** (with respect to a line drawn from the forward point **84**), and the forward point **84** is located on the bottom wall **82** of the sole plate **68**, the sole structure **34** in the transition zone **102** slopes toward (up or down, depending upon the view) the bottom wall **82** to define an undulating portion **104** of the forward end of the outsole **64** and the midsole structure **66**.

Comparing FIG. **4** with FIG. **3**, the deepest point **94** is farther away from the forward point **84** in FIG. **4** than in FIG. **3**. This difference in the location of the deepest point **94** leads to a difference in the respective transition zones **102** of FIG. **3** versus FIG. **4**. In FIG. **4**, the transition zone **102** is a single segment that is bounded by the exposed forefoot edge **98** which is closer to the forward point **84** than the transition line **100** is to the forward point **84**, and bounded along the sides by the lateral side **38** and the medial side **40**. Again, the transition zone **102** slopes toward the bottom wall **82** of the sole plate **68** along the undulating portion **104**. FIGS. **3** and **4** show how the location of the deepest point **94** can influence the size and shape of the transition zone **102**.

Referring to FIGS. **1-5**, the undulating portion **104** and the plurality of spikes **70** (see FIGS. **3** and **4**) are helpful in that they can provide improvements to a runner's performance. The article of footwear **30** shown in FIG. **1** has characteristics that are designed to help a runner run faster, especially during a high-speed race (e.g. during a 10 kilometer race). First, the plurality of spikes **70** in the forefoot region **42** improve the gripping to the ground during different phases of a runner's footstep, as will be discussed in more detail when discussing FIGS. **6-13**. The location of each of the plurality of spikes **70** is chosen or identified to enhance a runner's performance during different phases of a runner's footstep. Second, as the sole plate **68** has less depth than the sole structure **34** of the midfoot region **44**, the shoe **30** naturally facilitates an increase in a runner's angle of inclination, which improves running performance as well. In general terms, the faster a runner moves, the higher the angle of inclination within a certain range helps improve the runner's acceleration, and therefore speed (see the discussion of FIG. **8** below).

Referring specifically to FIGS. **3** and **4**, the plurality of spikes **70** are located in the exposed forefoot region **96** of the forefoot region **42**. The plurality of spikes **70** project away from the upper **32** along the bottom wall **82** of the sole plate **68**. The plurality of spikes **70** are protuberances that have a deeply tapered or spike shape, and may be integrally formed with the sole plate **68**, overmolded (not shown) into a corresponding plurality of apertures (not shown), or may have a threaded end (not shown) that is secured into corresponding threads (not shown) in the corresponding plurality of apertures. The plurality of spikes **70** can be made of a rigid plastic material or a metallic material. In some embodiments, the plurality of spikes **70** include a first spike **106**, a second spike **108**, a third spike **110**, and a fourth spike **112**. In some embodiments, each of the plurality of spikes **70** are identical. In other embodiments, one, some, or all of the plurality of spikes **70** can be varied from one another in shape, in size, or in material.

Still referring to FIGS. **3** and **4**, in addition to the plurality of spikes **70** in the exposed forefoot region **96**, the exposed forefoot region **96** may also have a plurality of barbs **114** (see also FIGS. **6** and **7**) as well as, or alternatively, a plurality of teeth (not shown). The plurality of barbs **114** are formed integrally with the bottom wall **82** of the sole plate **68**. Each of the plurality of barbs **114** is shorter in height than each of the plurality of spikes **70**, which collectively enhance the gripping and traction to the ground. The plurality of barbs **114** are generally circular in cross section, the cross section taken parallel with the bottom wall **82**, while the plurality of teeth are generally oval in cross section.

As shown in FIG. **3**, the sole plate **68** extends at least partially through the midfoot region **44**. In some embodiments the sole plate **68** is exposed at the cutout portion **92** as well as at the exposed forefoot region **96** of the forefoot region **42**. In some embodiments, the sole plate **68** is disposed adjacent an arched section **116** of the article of footwear **30**. In other embodiments, the ground-engaging surface is not continuous along the medial side **40** of the midfoot region **44** of the article of footwear **30**. For example, as illustrated in FIG. **3**, the outsole **64** partially surrounds the arched section **116**, and the midsole structure **66** partially defines the arched section **116**. The arched section **116** can be viewed as the area of transition from the cutout portion **92** to the bottom wall **72**.

In FIG. **6**, the forefoot region **42** is shown in its entirety, along with a portion of the midfoot region **44**. The exposed forefoot region **96** and the exposed forefoot edge **98** expose or uncover the bottom wall **82** of the sole plate **68**. The forward point **84**, the deepest point **94**, and the transition line **100** are all shown. The transition line **100**, the exposed forefoot edge **98**, the medial side **40**, and the lateral side **38** collectively define the transition zone **102**. In FIG. **6**, the transition line **100** is farther away from the forward point **84** than the exposed forefoot edge **98** is from the medial side **40** to the lateral side **38** of the shoe **30**. The plurality of spikes **70** including the first spike **106**, second spike **108**, third spike **110**, and fourth spike **112** are shown being disposed along or within the bottom wall **82**. In the present embodiment, the exposed forefoot edge **98** is not a straight line, but instead is a wavy line with two curves to accommodate the first spike **106** and the second spike **108**. The wavy line defines three inflection points, but may define two, or four, or five, or six, or more inflection points. The first spike **106** is positioned on the lateral side **38** of the shoe **30** and adjacent to the exposed forefoot edge **98**. The second spike **108** is positioned on the medial side **40** of the shoe **30** and adjacent to the exposed forefoot edge **98**. The third spike **110** and the fourth spike **112** are positioned adjacent to the forward point **84**. The fourth spike is **112** is closer to the lateral side **38** of the shoe **30** than the medial side **40** of the shoe **30** (see FIGS. **3**, **4**, and **6**).

Still referring to FIG. **6**, each of the plurality of spikes **70** has an embossment **118** that slightly projects from the bottom wall **82** and concentrically surrounds each of the plurality of spikes **70**. In some embodiments, the plurality of spikes **70** have no corresponding embossment **118**. In some embodiments, the embossment **118** can be circular, square, hexagonal, diamond, star or another shape. The embossment **118** does not project as far as any of the plurality of spikes **70**. The bottom wall **82** also has the plurality of barbs **114** that project from the bottom wall **82** away from the upper **32** (see FIG. **1**), but not as far as the projection of any of the plurality of spikes **70**. Each of the plurality of barbs **114** has a generally circular cross section in a plane parallel to the bottom wall **82**. In some embodiments, the bottom wall **82** may have a plurality of teeth (not shown) that project from the bottom wall **82** away from the upper **32**, but not as far as the projection of any of the plurality of spikes **70**. Each of the plurality of teeth has a generally oval cross section in a plane parallel to the bottom wall **82**. The plurality of barbs **114** and/or the plurality of teeth, if present, are integrally formed with the bottom wall **82** of the sole plate **68**. The plurality of barbs **114** and/or the plurality of teeth, if present, are configured to improve traction with the ground. In some embodiments, neither the plurality of barbs **114** nor a plurality of teeth are present. In some embodiments, the plurality of spikes **70** extend beyond the deepest point **94**, and in some embodiments, the plurality of spikes **70** do not extend beyond the deepest point **94**.

Referring to FIG. **7**, the forefoot region **42** is shown in its entirety, along with a portion of the midfoot region **44**. The exposed forefoot region **96** and the exposed forefoot edge **98** expose or uncover the bottom wall **82** of the sole plate **68**. The forward point **84** and the deepest point **94** are both shown. The rounded front **78** is shown projecting toward the upper **32** (see FIG. **1**) near the forward point **84**. The plurality of barbs **114** and two of the plurality of spikes **70** are shown, namely the second spike **108** and the third spike **110**. In addition, the main axis **90** projects from and intersects the forward point **84**. An inclination line **120** intersects the deepest point **94** and the forward point **84** (see FIGS. **7** and **15**). An inclination angle **122** is located at the forward point **84** and between the inclination line **120** and the main axis **90**.

The inclination angle **122** provides a way to measure how much the shoe **30** is configured to facilitate an increase in the angle of inclination of the runner. Since the sole structure **34** (see FIG. **1**) in the exposed forefoot region **96** is not as deep as the sole structure **34** in the midfoot region **44** and the outsole **64**, the shoe **30** is structured to facilitate a runner tilting forward during a footstep. In other words, the structure and shape of the shoe **30** tends to increase the runner's angle of inclination. When the deepest point **94** is more forward in the midfoot region **44** and the exposed forefoot region **96** is reduced in size, the inclination angle **122** becomes larger. When the deepest point **94** is more rearward in the midfoot region **44** and the exposed forefoot region **96** is configured larger, the inclination angle **122** becomes smaller. The inclination angle **122** provides a way to manipulate the angle of inclination of the runner. The inclination angle **122** can be between about two and about 30 degrees, or between about three and about 20 degrees, or between about four and about 15 degrees, or between about five and about 10 degrees, or between about six and about eight degrees. The inclination angle **122** also provides an indication of the amount of exposed forefoot region **96** present. The lack of the outsole **64** and the midsole structure **66** in the exposed forefoot region **96** is also helpful in reducing losses during a footstep (see FIG. **9** and the discussion of FIG. **9** below).

FIG. **8** is a graph illustrating a group of runner's average force vector in the vertical and horizontal directions, depending upon the specific group of runner's angle of inclination. Four groups of runners were observed and measured. A first group **124**, a second group **126**, a third group **128**, and a fourth group **130** of runners, each respectively presented as force vector lines, represent groups of runners who were measured while running at different angles of inclination. For example, the first group **124** is a group of runners having a measured angle of inclination of 0.2 degrees. This means that the runners in the first group **124** leaned forward very little compared to the other groups **126**, **128**, **130** while running. The horizontal x axis represents the magnitude of horizontal force produced, and the vertical y axis represents the vertical force produced by the various groups **124**, **126**, **128**, **130**. The amount of horizontal force, i.e., moving forward, produced by the first group **124** was compared to the amount of vertical force, i.e., moving up and down, produced by the first group **124**. This ratio of vertical force produced versus horizontal force produced is presented as the vector that represents the first group **124** in FIG. **8**.

The second group **126** had a measured angle of inclination of 0.5 degrees, the third group **128** had a measured angle of

inclination of 0.8 degrees, and the fourth group **130** had a measured angle of inclination of 1.1 degrees. This means that the second group **126** leaned forward more than the first group **124**, but less than the third group **128** and the fourth group **130**. For each group, the more the group leaned forward, the more horizontal force was produced compared to the amount of vertical force produced. As a result, the force vector for the first group **124** is the farthest to the left, and the force vector for the fourth group **130** is the farthest to the right in the graph of FIG. **8**. This indicates that horizontal force, and therefore speed, was generated more efficiently as the runner's angle of inclination was increased. Therefore, the graph depicted in FIG. **8** supports the general conclusion that a runner with a higher angle of inclination generally runs more efficiently. The inclination angle **122** (see FIGS. **7** and **15**) of the shoe **30** (see FIG. **1**) provides a way to help increase the angle of inclination of a runner.

FIGS. **9-11** illustrate a sequence of images of a runner during a first phase **132** (FIG. **9**), a second phase **134** (FIG. **10**), and a third phase **136** (FIG. **11**) of a footstep. Referring to FIG. **9**, the first or landing phase **132** shows a runner taking a footstep, and the shoe **30** has initial contact with the ground. When the shoe **30** contacts the ground initially, energy from the runner is spent compressing the shoe **30**. The runner does not move faster in the horizontal direction during the first phase **132**, but slows down instead. This slowdown reduces the runner's momentum. As a result, any configuration of the shoe **30** that can reduce this loss of energy during the first phase **132** will improve a runner's racing performance.

The article of footwear **30** of FIG. **1** has four features that reduce the amount of momentum lost from the first phase **132**. First, the outsole **64** and the midsole structure **66** is absent from the exposed forefoot region **96**, which reduces the amount of compression experienced by the midsole structure **66** and the outsole **64**. Second, the sole plate **68** absorbs the majority of the first phase **132** as the shoe **30** contacts ground in the forefoot region **42**. Since the sole plate **68** is comparatively rigid, the sole plate **68** springs back after compression. Much of the compression forces experienced by the sole plate **68** in the forefoot region **42** will be returned when the sole plate **68** springs back (see the discussion of the sole plate **68** material above in the discussion of FIGS. **1** and **2**). Third, the inclination angle **122** (see FIGS. **7** and **15**) of the shoe **30** facilitates the increase in the runner's angle of inclination. As noted with respect to FIG. **8** above, this increase in the runner's angle of inclination leads to less vertical force being wasted and more valuable horizontal forces being produced. Fourth, the plurality of spikes **70** in the forefoot region **42** (see FIG. **3**) concentrate the forces of the first phase **132** to drive the plurality of spikes **70** securely into contact with the ground, thereby providing a stronger ground contact with the shoe **30** during the first phase **132**. This driving of the plurality of the spikes **70** into secure contact with the ground will be beneficial in the later phases as well.

In FIG. **10**, the second or propulsion phase **134** shows a runner taking a footstep, with the shoe **30** being in contact with the ground, and the runner being propelled forward with respect to the position of the shoe **30**. The majority of the horizontal force, and therefore speed, produced during a footstep is during the second phase **134**. Comparing FIG. **9** to FIG. **10**, the shoe **30** begins the first phase **132** positioned in front of the body of the runner, but during the second phase **134** the shoe **30** ends positioned behind the body of the runner. The shoe **30** does not move from the first phase **132** to the second phase **134**. Instead, the body of the runner moves forward in relation to the shoe **30**. The body of the runner moves forward during the second phase **134** due to a combination of forward momentum and the additional horizontal force produced by the runner during the second phase **134**. As a result, any configuration of the shoe **30** that increases the additional horizontal force during the second phase **134** improves a runner's performance.

The article of footwear **30** of FIG. **1** has several features that increase the additional horizontal force produced during the second phase **134** (see FIG. **10**). First, the plurality of spikes **70** and the plurality of barbs **114** (see FIG. **3**) ensure that the contact with the ground is strong, so that a runner can push as hard as the runner desires without losing traction. Second, the inclination angle **122** (see FIGS. **7** and **15**) concentrates most of the second phase **134** contact into the exposed forefoot region **96** of the shoe **30**, thereby reducing contact with the heel region **46** and the midfoot region **44**. Since contact is reduced in the heel region **46** and the midfoot region **44**, the amount of midsole structure **66** compressed is reduced. In addition, during this second phase **134** the sole plate **68** springs back to the original, pre-compression shape of the sole plate **68**, and that energy is used to help propel the runner forward. Third, the inclination angle **122** also helps to facilitate the runner naturally having a higher angle of inclination during the second phase **134**, which produces more valuable horizontal force and less wasted vertical force (see the discussion of FIG. **8** above). Fourth, because the bottom of the shoe **30** is effectively sloped due to the inclination angle **122**, the stride of the second phase **134** is extended slightly at the end of the second phase **134**, which provides more opportunity to produce more horizontal force.

Referring to FIG. **11**, the third or toe off phase **136** shows a runner taking a footstep, and the shoe **30** is beginning to break contact with the ground. The runner is continuing to propel his body forward with respect to a position of the shoe **30** until the moment the shoe **30** breaks contact with the ground. Although the third phase **136** is a relatively short phase, the phase represents a great opportunity to maximize increasing the horizontal force produced during the footstep. When or if the shoe **30** loses traction with respect to the ground, energy can be lost. In addition, if the shoe **30** loses traction, the next footsteps of the runner may be affected due to a slight loss of balance, along with the loss of forward momentum. During a race where tenths of a second make a difference between first place and last place, a loss of traction of the shoe **30** during the third phase **136** could be that difference. As a result, maintaining good traction throughout the third phase **136** can greatly improve the performance of the runner.

The shoe **30** begins the second phase **134** (see FIG. **10**) positioned behind the body of the runner, and during the third phase **136** the shoe **30** is still positioned behind the body of the runner. The shoe **30** remains in contact with the ground. Movement of the shoe **30** between the second phase **134** and the third phase **136** is related to a pivot or rotation of the shoe **30** as the shoe **30** rises up to break contact with the ground (see FIG. **11**). As a result, any configuration of the shoe **30** that can help prevent a loss of traction during the third phase **136** and increase the horizontal force produced during the third phase **136** will improve a runner's racing performance.

The article of footwear **30** of FIG. **1** has several features that create good traction with the ground during the third phase **136** (see FIG. **11**) and increase the horizontal force produced during the third phase **136**. First, the plurality of spikes **70** and the plurality of barbs **114** (see FIG. **3**) ensure

that the contact with the ground is strong, so that a runner can push as hard as the runner wants with less fear of slipping and losing contact with the ground. Second, the inclination angle **122** (see FIGS. **7** and **15**) concentrates most of the third phase **136** contact in the exposed forefoot region **96** of the shoe **30**. The sole plate **68**, during the third phase **136**, either springs back to the original (pre-compression) shape of the sole plate **68**, or already has sprung back, such that the plurality of spikes **70** are positioned as best as possible to maintain a strong contact with the ground. Third, the inclination angle **122** also helps facilitate the runner utilizing a higher angle of inclination during the third phase **136**, which produces more valuable horizontal force and less wasted vertical force (see the discussion of FIG. **8** above).

FIG. **12** illustrates various phases of a footstep. The foot depicted in FIG. **12** is a generic foot, and is not the same as the shoe **30** of FIG. **1**. The beginning of a first phase **132** for a runner running a race is different than the beginning of the first phase **132** for a walker doing slow paces during a leisurely stroll. An initial contact for slower speeds can be in a first or heel point **138**. For faster speeds, the initial contact can be in a second or midfoot point **140**, and for the fastest speeds, the initial contact can be in a third or forefoot point **142**. This is, in part, about keeping balance for the runner. The faster a runner moves horizontally, the more that the runner can lean forward while maintaining their balance. However, at slower speeds, the horizontal force produced by the runner is reduced, and the angle of inclination of the runner is naturally reduced to maintain balance. Therefore, the initial contact for a fast-moving runner is generally farther forward in the foot than for a slower moving walker. The angle of the foot during the second phase **134** is shown, and reinforces that the body of the runner is behind the shoe **30** (and hence foot) during the first phase **132**, but is in front of the shoe **30** during the later portion of the second phase **134**. The foot begins to lift up vertically as the foot rotates during the third phase **136**. Based on the orientation of the foot during the third phase **136**, one or more spikes **70** (see FIG. **3**) will improve the contact between the ground and the shoe **30** during the third phase **136**.

FIG. **13** illustrates zones for the first phase **132** (see FIG. **12**), the second phase **134** (see FIG. **12**), and the third phase **136** (see FIG. **12**) on the bottom of the (left) shoe **30** of FIG. **1**. These zones collectively suggest where to locate each of the plurality of spikes **70** to create a desirable result. First, a landing zone **144** has been identified on the lateral side **38** of the forefoot region **42**, where the first phase **132** has the most contact with the shoe **30**. To ensure that the shoe **30** does not experience excessive traction (i.e., excessive braking forces) during the first phase **132**, this landing zone **144** operates best by having fewer spikes present to provide enough traction to create enough contact with the ground during the first phase **132** without creating excessive traction or braking forces. Second, a propulsion zone **146** has been identified on the medial side **40** of the forefoot region **42**, where the second phase **134** produces the most forward force. Traction in this propulsion zone **146** should be kept relatively high to ensure that the maximum horizontal force is produced during the second phase **134**. This increased traction can be produced by having at least one of the plurality of spikes **70** present in the propulsion zone **146**. Third, a contact zone **148** has been identified on the front of the forefoot region **42** near the forward point **84**, where contact during the third phase **136** is most prevalent. Traction in this contact zone **148** should be kept relatively high to ensure that sufficient contact between the ground and the shoe **30** is maintained during the third phase **136**, which again could otherwise reduce the horizontal force produced during the third phase **136**. This increased traction can be produced by having at least one of the plurality of spikes **70** present in the contact zone **148**.

Referring to FIGS. **3** and **13**, based upon these findings, the location of the plurality of spikes **70** in at least one embodiment is directed to ensuring that the propulsion zone **146** and the contact zone **148** have plenty of traction, and that the landing zone **144** has sufficient traction during the first phase **132** without having an excessive amount of traction. The first spike **106** is positioned on the lateral side **38** of the shoe **30** and adjacent to the exposed forefoot edge **98**. This location corresponds with the landing zone **144** of the first phase **132** discussed above. The first spike **106** provides enough traction to keep contact between the shoe **30** and the ground during the first phase **132** without creating an excessive amount of traction by placing too many of the plurality of spikes **70** in the landing zone **144**. The second spike **108** is positioned on the medial side **40** of the shoe **30** and adjacent to the exposed forefoot edge **98**. This corresponds with the propulsion zone **146** of the second phase **134** discussed above. The second spike **108** ensures that the propulsion zone **146** has sufficient traction to ensure that the second phase **134** can produce as much horizontal force as possible. The third spike **110** and the fourth spike **112** are positioned adjacent to the forward point **84**. This corresponds with the contact zone **148** of the third phase **136** discussed above. The third spike **110** and the fourth spike **112** provide as much traction as possible to help create a strong contact between the shoe **30** and the ground during the third phase **136** to provide as much horizontal force as possible.

FIG. **14** is a cross section taken through line **14-14** of FIG. **3**, and FIG. **15** is a cross section taken through line **15-15** of FIG. **3**. Both FIGS. **14** and **15** show the bottom wall **72**, the outsole **64**, the first midsole member **74**, the second midsole member **76**, the sole plate **68**, the bottom wall **82** of the sole plate **68**, the rounded front **78**, as well as the forefoot region **42**, the midfoot region **44**, the heel region **46** (see FIG. **15** for the latter three elements), and the exposed forefoot region **96**. In addition, FIGS. **14** and **15** show the forward point **84**, the rearward point **86**, the deepest point **94**, the undulation portion **104** and the transition zone **102**. Further, the main axis **90**, the transition line **100** (for a better view, see FIG. **6**), the inclination line **120** (see FIG. **15**) and the inclination angle **122** (see FIG. **15**) are also shown. FIGS. **14** and **15** also show that the deepest point **94** is not necessarily the lowest point, but depending upon the shape of the slope of the transition zone **102** may be a shorter point that is unobstructed by the first midsole member **74**, the second midsole member **76**, or the outsole **64**. The second spike **108** and the third spike **110** are shown in FIG. **14**, and the first spike **106** is shown in FIG. **15**. The fourth spike **112** has been removed in FIG. **15** to provide more clarity to the inclination angle **122** (see FIG. **3** for a clearer view of all four spikes **106**, **108**, **110**, **112**).

FIGS. **14** and **15** collectively show how the location of the plurality of spikes **70** in the exposed forefoot region **96** and the inclination angle **122** (see FIG. **15**) are helpful for producing the advantages that the shoe **30** can provide. A runner during a race may lose less energy during the first phase **132** (see FIG. **9**), and gain more energy or speed during the second phase **134** (see FIG. **10**) wearing the shoe **30** disclosed herein as a result of an increased angle of inclination facilitated by the inclination angle **122** (see FIG. **15**), the location of the plurality of spikes **70**, and the spring back features of the sole plate **68** (see FIG. **3**). In addition,

the location of the plurality of spikes **70** will assist in providing a way to produce more horizontal power during the third phase **136** (see FIG. **11**). Also, the reduction of the midsole structure **66** and the outsole **64** in the exposed forefoot region **96** reduces the weight of the shoe **30** as well. For all of these reasons, all of the embodiments of the shoe **30** disclosed herein provide for improvements in running performance during races.

Any of the embodiments described herein may be modified to include any of the structures or methodologies disclosed in connection with different embodiments. Further, the present disclosure is not limited to articles of footwear of the type specifically shown. The aspects of the articles of footwear of any of the embodiments disclosed herein may be modified to work with any type of footwear, apparel, or other athletic equipment.

As noted previously, it will be appreciated by those skilled in the art that while the invention has been described above in connection with particular embodiments and examples, the invention is not necessarily so limited, and that numerous other embodiments, examples, uses, modifications and departures from the embodiments, examples and uses are intended to be encompassed by the claims attached hereto. The entire disclosure of each patent and publication cited herein is incorporated by reference, as if each such patent or publication were individually incorporated by reference herein. Various features and advantages of the invention are set forth in the following claims.

INDUSTRIAL APPLICABILITY

Numerous modifications to the present invention will be apparent to those skilled in the art in view of the foregoing description. Accordingly, this description is to be construed as illustrative only and is presented for the purpose of enabling those skilled in the art to make and use the invention. The exclusive rights to all modifications which come within the scope of the appended claims are reserved.

We claim:

1. A sole structure for an article of footwear having an upper, a forefoot region, a midfoot region, a heel region, a medial side, and a lateral side, further comprising:

an outsole having an outer wall located along an exterior of the outsole and the exterior of the outsole being configured to be a ground-engaging surface;

a sole plate configured to be positioned adjacent the upper, the sole plate having a bottom wall, a forward end, an exposed forefoot region, a front, and a plurality of spikes; and

a midsole structure positioned between the sole plate and the outsole,

wherein the forward end is located at a point in the forefoot region farthest away from the heel region,

wherein the front is located at the forward end,

wherein a forward point is located along the bottom wall at the front,

wherein a rearward point is located along the bottom wall and farthest away from the forward point,

wherein a main axis line is defined as a line that intersects the forward point and the rearward point,

wherein the exposed forefoot region is located in the forefoot region and is not covered by the outsole or the midsole structure,

wherein the outer wall has a deepest point in the midfoot region,

wherein the deepest point is defined as a point that forms a largest angle between the main axis line and an inclination line, the inclination line is defined as a line that intersects the forward point and a point on the outer wall that is not obstructed by the midsole structure or the outsole,

wherein an inclination angle is defined as an angle formed between the main axis line and the inclination line,

wherein the inclination angle is between two and 30 degrees, and

wherein the ground-engaging surface of the outsole in the midfoot region is spaced apart and separate from the ground-engaging surface of the outsole in the heel region on each of the medial side and the lateral side of the sole structure.

2. The sole structure of claim **1**, wherein the inclination angle is between three and 20 degrees.

3. The sole structure of claim **1**, wherein the inclination angle is between four and 15 degrees.

4. The sole structure of claim **1**, wherein the inclination angle is between five and 10 degrees.

5. The sole structure of claim **1**, wherein the inclination angle is between six and eight degrees.

6. A sole structure for an article of footwear having an upper, a forefoot region, a midfoot region, a heel region, a medial side, and a lateral side, further comprising:

an outsole having an outer wall located along an exterior of the outsole and the exterior of the outsole being configured to be a ground-engaging surface;

a sole plate configured to be positioned adjacent to the upper, the sole plate having a bottom wall, a forward end, an exposed forefoot region, a front, and a plurality of spikes; and

a midsole structure positioned between the sole plate and the outsole,

wherein the exposed forefoot region is located in the forefoot region and is not covered by the outsole or the midsole structure,

wherein the plurality of spikes are located in the exposed forefoot region,

wherein an exposed forefoot edge defines an edge between the exposed forefoot region and the midsole structure or the outsole,

wherein at least one of the plurality of spikes is located adjacent to the medial side and the exposed forefoot edge,

wherein at least one of the plurality of spikes is located adjacent to the lateral side and the exposed forefoot edge,

wherein at least one of the plurality of spikes is located adjacent to a forward point,

wherein the exposed forefoot edge includes at least two inflection points, and

wherein a portion of the sole plate in the forefoot region is directly exposed to a ground surface when the sole structure is resting on the ground surface.

7. The sole structure of claim **6**, wherein the plurality of spikes has a first spike, a second spike, a third spike, and a fourth spike.

8. The sole structure of claim **7**, wherein the third spike, and the fourth spike are located adjacent to the forward point.

9. The sole structure of claim **6**, wherein the exposed forefoot region has a plurality of barbs, wherein each of the plurality of barbs is shorter than each of the plurality of spikes, and

wherein the plurality of barbs includes a circular cross section in a plane parallel to the bottom wall.

10. The sole structure of claim 6, wherein the front projects away from the bottom wall and toward the upper.

11. The sole structure of claim 6, wherein each of the plurality of spikes has an embossment that projects from the bottom wall and concentrically surrounds each of the plurality of spikes.

12. The sole structure of claim 6, wherein the midfoot region or the heel region has a cutout portion where the bottom wall is not covered by the midsole structure or the outsole.

13. A sole structure for an article of footwear having an upper, a forefoot region, a midfoot region, a heel region, a medial side, and a lateral side, further comprising:

an outsole having an outer wall located along an exterior of the outsole and the exterior of the outsole being configured to be a ground-engaging surface;

a sole plate configured to be positioned adjacent to the upper, the sole plate having a bottom wall, a forward end, an exposed forefoot region, a front, and a plurality of spikes, and

a midsole structure including a first midsole member and a second midsole member, the midsole structure extending between the midfoot region and the heel region,

wherein the exposed forefoot region is located in the forefoot region and is not covered by the outsole or the midsole structure,

wherein an exposed forefoot edge defines an edge between the exposed forefoot region and the midsole structure or the outsole,

wherein the forward end is located at a point in the forefoot region farthest away from the heel region,

wherein the front is located at the forward end,

wherein a forward point is located along the bottom wall and at the front,

wherein a rearward point is located along the bottom wall and farthest away from the forward point,

wherein a main axis line is defined as a line that intersects the forward point and the rearward point,

wherein the outer wall has a deepest point in the midfoot region,

wherein the deepest point is defined as a point that forms a largest angle between the main axis line and an inclination line, the inclination line is defined as a line that intersects the forward point and a point on the outer wall that is not obstructed by the midsole structure or the outsole,

wherein a transition line is located along the bottom wall, projecting perpendicularly with respect to the main axis line, extends from the lateral side to the medial side, and closest to the deepest point,

wherein an undulating portion is defined as a region bounded by the transition line and the exposed forefoot edge, extending from the medial side to the lateral side,

wherein the sole structure within the undulating portion slopes toward the bottom wall,

wherein the first midsole member is in direct contact with the outsole in the heel region and the second midsole member is in direct contact with the sole plate, and

wherein the first midsole member is disposed entirely below the second midsole member in the heel region when the article of footwear is resting on a ground surface.

14. The sole structure of claim 13, wherein the front projects away from the bottom wall and toward the upper.

15. The sole structure of claim 13, wherein the exposed forefoot edge is a wavy and continuous line.

16. The sole structure of claim 13, wherein the plurality of spikes are integrally formed with the sole plate.

17. The sole structure of claim 13, wherein the plurality of spikes includes a first spike, a second spike, a third spike, and a fourth spike.

18. The sole structure of claim 17, wherein the first spike is located adjacent to the exposed forefoot edge and the lateral side, and the second spike is located adjacent to the exposed forefoot edge and the medial side.

19. The sole structure of claim 18, wherein the third spike and the fourth spike are located adjacent to the forward point.

20. The sole structure of claim 19, wherein an inclination angle is defined as an angle formed between the main axis line and the inclination line, and

wherein the inclination angle is between 2 and 30 degrees.

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